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Science & Technology

USSR: Earth Sciences

Science & Technology
USSR: Earth Sciences

CONTENTS

PHYSICS OF ATMOSPHERE

ECOLOGY

Electromagnetic Emission Accompanying Dynamic Processes in Ice

[Article by V. V. Bogorodskiy, corresponding member, USSR Academy of Sciences (deceased), A. V. Gusev, V. A. Nikitin and M. B. Yartsev, Arctic and Antarctic Scientific Research Institute, Leningrad]

[Abstract] Although the range of electromagnetic emission 10^{-3}-10^1 MHz has been studied and physical processes leading to formation of sources of electromagnetic disturbances in a broad frequency spectrum have been defined, ice has rarely been included in such research. This article gives the principal experimental results of study of ELF electromagnetic fields (0.5-30 Hz) and their disturbances during destruction of ice samples. The instrumentation used was described earlier (A. B. Gusev, et al., GEOMAGNETIZM I AERONOMIYA, Vol 22, No 2, pp 272-278, 1983). The dependence of the intensity of electromagnetic emission on epicentral distance and rate of sample loading was determined. A study was also made of the dependence of the intensity of registered electromagnetic emission on relative orientation of the axes of the receivers and plane of ice sample destruction. The maximal energy is emitted in the plane perpendicular to the plane of sample destruction. Research was carried out at an ice temperature -15-40°C, salinity 1-2.5o/oo, density 850-880 kg/m³ and velocities of longitudinal and transverse waves in ice 3250-3700 and 1650-1950 m/s respectively. Sample length varied from 0.5 to 1.5 m. The range of working pressure in the system was 0-3 MPa and the loading rate was varied in the range 0.01-0.4 MPa/s, taking in virtually all loading rates possible under natural conditions during dynamic processes in the ice cover. In the frequency band 0.5-30 Hz during ice destruction electromagnetic emission of a horizontal electrical dipole was registered which in amplitude is comparable to the natural electromagnetic field level under undisturbed conditions. Polarization and attenuation of the studied process was observed. Figure 1; references: 8 Russian.

Reason for Antarctic Aseismicity

[Article by M. A. Sadovskiy, academician, and Yu. N. Avsyuk, Earth Physics Institute imeni O. Yu. Shmidt, USSR Academy of Sciences, Moscow]

[Abstract] Earthquake epicenters surround the Antarctic continent but are absent within it, a pattern which is not true of the Arctic region. The aseismicity of the Antarctic continent is an experimentally established fact, although it is characterized by the entire range of relief-forming features present on all other continents. The only difference is that the continent is completely covered by ice, a plastic material, with the ice filling the troughs and having a small thickness over elevated sectors of the crust. The continental dissection has been smoothed (both erosional processes and continental glaciation sharply reduce seismicity). An explanation of the observed aseismicity is proposed on the basis of the concept of a block-hierarchical geophysical medium. It is shown that geological processes such as erosion, sedimentation and glaciation, with which the redistribution of masses is associated, can result in a dropoff of seismic activity, a result of minimizing of the relative movements of blocks in the crustal structure. There is no need for any exotic explanation of Antarctic aseismicity. It is readily explained on the basis of the described model of a dynamically stressed geophysical medium, which is shown to be capable of explaining both the normal and "pathological" development of the process of regional seismic activity. Figures 4; references 12: 9 Russian, 3 Western.

Winter Ice Concentration Variations in the Arctic Seas Under Wind Action

[Article by Ye. V. Semenov, candidate of geographical sciences, and B. M. Taran, State Oceanographic Institute]

[Abstract] A relatively simple numerical model of wind-generated ice drift is presented by means of which ice conditions in the USSR arctic seas are calculated for the main kinds of atmospheric circulation and the average winter multiyear circulation. The results obtained are of particular interest inasmuch as they yield a general picture of the distribution of the ice cover characteristics of each kind of atmospheric circulation. The hydrodynamic model of ice drift is constructed for an island-punctuated basin having solid and liquid borders; the ice cover is examined as an aggregate of solid incompressible ice floes. Other model restrictions: only tangential wind stress is taken into account; heat conditions are disregarded; the ice drift in motionless water. Despite the simplicity of this wind-generated ice drift model, it does provide useful data on arctic ice conditions and their deviations from average multiyear conditions. The data are of definite prognostic value when long-term forecasts of circulation types are available. The results of calculations are found to be in good agreement with earlier published observational data. Figures 2, formulas 15, references 6 (Russian).

Residual Phenomena Accompanying Large-Scale Underground Shots

[Article by V. V. Adushkin, A. A. Spivak, M. M. Krekov, M. G. Starshinina and S. K. Daragan, Earth Physics Institute imeni O. Yu. Shmidt, USSR Academy of Sciences]

[Abstract] Some results of research on seismic phenomena initiated by large-scale underground shots are presented. Instrumental observations were made using digital and and analog seismic registry systems. The primary transducers for measuring motion of the medium were SM-3 KV seismic detectors; digital registry was with K-PRS field stations. The observation network consisted of several peripheral seismic registry points spaced at distances 100 to 1500 m from one another and a central point for the collection, storage and preliminary processing of data. Registry of induced seismicity was carried out for eight underground shots with a power 0.3 to 150 kilotons in bedrock. The total duration of observations was governed by the lifetime of aftershock emission. Registry was at nighttime when the noise level was low. The aftershocks constitute a series of seismic pulses with an amplitude from 100 to 20 000 nm/s. The seismic signals were registered no sooner than 3 hours after a shot and constitute a train of sign-variable oscillations with a frequency from 5 to 16 Hz and a duration from 2 to 5 s. A total of 100-500 seismic events were registered during the observation time. The duration of the seismicity induced by a shot varied from 5 days to 2.5 months. The analyzed materials show that a study of aftershock seismicity initiated by underground shots and jlocalized in space and time can facilitate determination of the mechanisms of deformation of a block medium and the processes transpiring in it. The results can be useful in studying similar aftershock emission processes in the crust during natural strong earthquakes. Figures 10; references 12: 9 Russian, 3 Western.

Digital Filtering Graph for Suppressing Regular Interference Waves Associated With Use of Nonexplosive Sources

[Article by N. G. Davydov, I. D. Makhmudkhodzhayeva and G. N. Makhmudkhodzhayev, Turlan Geophysical Expedition, Kazgeofizika Geological Production Association; IGIRNIGM, Tashkent]

[Abstract] A method is proposed for the use of digital filters for suppressing the surface waves observed when using nonexplosive sources. The method is also effective when suppressing other types of regular wave interference, such as from multiply refracted and diffracted waves. In the USSR such problems are usually solved by such algorithms as those employed for the subtraction of elementary waves, for the subtraction of wave packets or for adaptive subtraction, but in all cases they require a priori statistical characteristics of the wave field and are time-consuming procedures. The basis for the proposed method, which is free of the mentioned difficulty, is a cyclic graph for the processing of two-dimensional seismic signals whose main elements are the following analysis and digital filtering programs: τ energy analysis; visualization of a two-dimensional filter; two-dimensional filtering and correcting filtering. The method was field tested using common depth point records for an oil-bearing region in the South Turgay depression. The mathematical model for this method is given. Application of the method is illustrated by a specific example, showing the effectiveness of suppression of interference by the described two-dimensional filtering procedures and with subsequent improvement in the signal-to-noise ratio by a multichannel correction filter. Figures 2.

Acoustic Disturbance From Underground Nuclear Shot as Source of Electrostatic Turbulence in Magnetosphere

[Article by M. B. Gokhberg, V. A. Pilipenko, O. A. Pokhotelov and S. Partasarati, Earth Physics Institute imeni O. Yu. Shmidt, USSR Academy of Sciences, Moscow; NASA Goddard Space Flight Center]

[Abstract] The MASSA experiment demonstrated that in ionospheric plasma there can be transformation of acoustic oscillations into different types of electromagnetic waves. An attempt was therefore made, using American satellite data, to find additional experimental proof of intensification of ionospheric electromagnetic turbulence as a result of a strong acoustic effect, such as from the shots set off regularly in Nevada and registered by low-flying satellites (emphasis is on data obtained using the DE-2 satellite). It is demonstrated that there are quite effective nonplasma sources of high-frequency ionospheric turbulence. The effects of transformation of acoustic oscillations into electromagnetic oscillations can serve as a physical basis for developing a method for monitoring nuclear tests (due to the strong influence of regional geology it is sometimes difficult to discriminate between nuclear shots and earthquakes). A detonation as a coherent source of an acoustic disturbance should

cause a greater effect in the ionosphere than an incoherent source, such as an earthquake. The ionospheric effect directly over an earthquake epicenter is considerably weaker than the Rayleigh wave forming at a distance from an epicenter. These and other considerations make it evident that satellite observations could supplement seismic and ionospheric methods for monitoring underground nuclear shots. Figures 4; references 15: 6 Russian, 9 Western.

UDC 528.38.089.6

Proposals on Reducing Influence of Systematic Errors in Highly Precise Leveling

[Article by Ye. Yanush (Poland)]

[Abstract] A number of systematic errors arise during highly precise leveling. In particular, a correction must be introduced for the mean length of a meter of the leveling rod. Several factors dictate this correction: inaccuracy in plotting lines and uneven tension on the invar tape; change in length of invar tape with a change in temperature; inconstancy in tension on the invar tape caused by change in the wooden body of the rod, instability of the spring and frictional resistance in the invar tape tension system; tendency of the invar tape to a change in length with aging, resulting in a progressive lengthening of the tape; tremors and impacts, exerting a negative influence on the invar tape and spring tension. The article describes a series of formulas, correction factors, devices and procedures for remedying these problems. These include the use of a specially fabricated spring and a lever which reduce friction of the axis of rotation. As a result of a humidity change from 35 to 100% there is a change in rod length up to 1 mm. This change is reduced to 0.2 mm if rods are stored at constant humidity, preferably at the mean multiyear humidity of the area in which work is to be done. References: 5 Russian.

UDC 550.31:539.3

Energy Restrictions on Effective Elastic Moduli of Anisotropic Microinhomogeneous Media

[Article by V. A. Kalinin and I. O. Bayuk, Earth Physics Institute imeni O. Yu. Shmidt, USSR Academy of Sciences, Moscow]

[Abstract] Most microinhomogeneous materials are macroanisotropic elastic bodies. The anisotropy of their properties is attributable to the technology of their fabrication and processing and for rocks are conditions for their formation and subsequent evolution. In the range of small deformations the stress and strain tensors are related by Hooke's law, but it is impossible to obtain a solution for the stress and strain fields in a microinhomogeneous body due to the need for taking the interaction of many bodies into account. An important problem is determination of the mean statistical elastic characteristics of a body as related to the mean macroscopic fields. The simplest solutions were obtained by W. Voight, LEHRBUCH DER KRISTALLPHYSIK, 1928, and A. Reuss, Z. ANGEW. MATH. UND MECH., Bd 9, No 1, 1929. The Voight approximation gives the upper limit of the effective elastic moduli, whereas the Reuss approximation gives their lower limit. The erroneous opinion is widespread that in the case of macroscopic bodies their elastic characteristics are limited upward by the Voight approximation and downward by the Reuss approximation. The purpose of this article is to demonstrate the unsoundness of such a generalization and to derive inequalities imposing limitations on the admissible values of the effective elastic moduli of macroanisotropic bodies of different symmetry systems. It is shown that the conditions determinining the ranges of admissible values of most components of the effective tensor have the form of systems of inequalities whose analysis is a complex problem. References 10: 6 Russian, 4 Western.

UDC 502.6:553.981/982

Evidence of Ecological-Geochemical Transformation of Soils Under Influence of Technogenic Hydrocarbon Gases and Their Remote Detection

[Article by G. I. Belchanskiy, A. N. Vasilyev, N. Ye. Zhuravel and A. P. Pichugin, Institute of Animal Evolutionary Morphology and Ecology imeni A. N. Severtsov, USSR Academy of Sciences, Moscow; Kharkov State University imeni A. M. Gorkiy]

[Abstract] Ecological-geochemical research was carried out in the territory of a major gas condensate deposit in the Ukraine. The work included a lithogasobiochemical survey of soils and subsoil deposits, chemical, granulometric and ionometric analyses of soil samples of the cultivated soil layer and photographing of soil surfaces. It was found that the development of hydrocarbon-oxidizing microflora and increased concentrations of hydrocarbons in soils result in a change in the aggregate state of the cultivated soil layer. The aggregate state of soils made it possible to detect a number of features of soil processes in zones of influence of technogenic hydrocarbons. These and other results make possible an approach to development of methods for geochemical sounding of the soil cover subjected to anthropogenic influences. Radar sounding is promising for indicating technogenic changes in the atmosphere (such as acid

GEOLOGY

rain) or beneath the soil layer (zones of hydrocarbon migration) leading to variation in the examined physicochemical parameters of the cultivated horizon. This is because the principal scatterer in radar sounding is surface roughnesses with a size on the order of radar wavelength. Experiments demonstrated a high efficiency of radar sounding of anomalous geophysical fields. The defined indicators of ecological-geochemical transformation of soils under the influence of anthropogenic impact can be used in evaluating the degree of its effect on the environment. Figure 1; references: 4: 3 Russian, 1 Western.

Conditions for Formation and Prediction of Strong Squalls Using Meteorological Radar and Artificial Earth Satellite Observational Data

[Article by V. F. Lapcheva, candidate of physical and mathematical sciences, USSR Hydrometeorological Scientific Research Center]

[Abstract] A study was made to ascertain the most informative parameters of the atmosphere and cloud cover determining the conditions for the formation and development of strong squalls (greater than 25 m/s) and to develop a simple, objective method for their prediction for the European USSR using data collected by meteorological radars and artificial satellites. It was discovered that already during the nighttime and early morning hours prior to a day with strong squalls radar maps and satellite images reveal regions of concentration of well-developed convective clouds with an upper radio echo boundary more than 11 km and characteristic specific patterns. These characteristic Cb ensembles are always combined with a definite state of the thermodynamic field determining conditions for the development of powerful convection. The form of cloud cover and its intensity at nighttime are an indicator of the energetic state of the atmosphere necessary for development of severe weather phenomena and the positive evolution of characteristic Cb ensembles at nighttime indicates the conservation of conditions favorable for the generation of instability energy. (These atmospheric parameters cannot be computed routinely using numerical models.) The places of occurrence of strong squalls was determined by finding the dependence of the rate of movement of the characteristic Cb ensembles on wind at the 500-gPa level. A method was developed for predicting strong squalls and methodological instructions were prepared in two variants for a time up to 18 hours in advance. The method was tested in 1988-1989 and recommended for use in practical work. Figures 2; references 11: 6 Russian, 5 Western.

Dynamics of Arctic Ice in Seasonal Energy Balance of Climate Model With Regional Resolution

[Article by M. P. Kolomeyev, candidate of physical and mathematical sciences, S. L. Malyshev and S. A. Nikonov, Tayfun Scientific Production Association]

[Abstract] On the basis of earlier work, a northern hemisphere arctic ice block was computed for inclusion in a seasonal energy balance model of climate with regional resolution. In models with this resolution level it must be taken into account that the ice cover parameters and the influence of ice on climate are dependent on geographical coordinates and although this has usually been done, strong simplifying assumptions have been made concerning structure of the ice cover which make impossible a correct description of the freezing and melting of ice. Earlier schemes lacked vertical resolution in the atmosphere, making impossible correct allowance for atmospheric circulation. The new block remedies these shortcomings (two atmospheric layers are discriminated: 1000-600 and 600-200 mb) and can be used in describing the principal characteristics of sea ice: mean thickness, fraction of area covered by leads and surface contribution to the energy balance. The characteristics of the ice cover and mean zonal temperatures computed using the new model are compared with empirical data. These data demonstrate the validity and effectiveness of the upgraded model for reproducing the properties of the ice cover and its influence on the energy balance of northern oceanic regions. Figures 3; references 25: 6 Russian, 19 Western.

Statistical Structure of Large-Scale Oceanological Fields in Newfoundland Energetic Test Range

[Article by A. V. Kolinko, candidate of physical and mathematical sciences, Odessa Division, State Oceanographic Institute]

[Abstract] The results of research on the statistical structure of the mean seasonal temperature and salinity fields computed at the points of intersection of a regular grid using data from 50 surveys (divided into the four seasons) in the Newfoundland Energetic Test Range (1981-1987) are given. The study was made by numerical analysis of water masses, making it possible to obtain diagrams of the distribution of water mass volumes as a function of a series of parameters and diagrams of water mass depths. The probability density functions for temperature and salinity are computed for each season for different oceanic layers (0-2000 m) and their temporal evolution and the change in their distribution with depth are analyzed. A method is proposed for quantitative estimates of the rates of change of macroscale temperature and salinity properties in the ocean and periods of "fast" and "slow" changes in thermohaline characteristics in the seasonal cycle are defined. During a "slow" period there is a change in the phases of the seasonal cycle and due to inertia the rate of change in properties is slowed. During "fast" periods the tendency observed

at the end of the preceding season continues and therefore the rate of changes in oceanic properties increases. The spring-summer "fast" changes in t.s characteristics are accompanied by an increase in current discharges. During the autumn-winter "fast" changes the ocean temperature drops off due to intensive heat exchange with the atmosphere, which favors convective exchange in the ocean itself. In turn, these processes accompany a tendency to a decrease in discharges of the macroscale system of warm currents. Figures 2; references 9: 8 Russian, 1 Western.

Application of Mathematical Models for Research on Climate-Permafrost Interrelationship

[Article by O. A. Anisimov, candidate of physical and mathematical sciences, and F. E. Nelson, professor, USSR State Hydrological Institute; Rutgers University]

[Abstract] The possibility of use of three different permafrost-climatic indices (soil-permafrost index, air-permafrost index, Stefan index relating depth of seasonal thawing and freezing of soil) characterizing the thermal regime of the atmospheric surface layer and the soil surface is examined relative to the detection, mapping and prediction of permafrost. The results of computations of "climatic" permafrost and its real boundaries are compared for the territory of Central Canada. The influence of the spatial variability of the mean depth of the snow cover on the accuracy of computations is analyzed. The use of a proposed model for determining the configuration of the cryolithic zone of the USSR is examined. A map of "climatic" permafrost for the USSR was compiled and is discussed. There is a satisfactory correspondence between the computed and real positions of the permafrost boundary when using the model, based on modern norms of climatic characteristics. The geocryolithic zone in the USSR in general corresponds to modern climate. This conclusion cannot be applied to the entire thickness of permafrost because its deep layers in some regions have a thermal regime indicating that degradation or aggradation processes are in progress, but applicable to the upper layer of several tens of meters this conclusion is valid. Figure 1; references 9: 4 Russian, 5 Western.

Limiting Possibilities of Long-Range Weather Forecasting Using Archival Data

[Article by A. A. Vinogradskaya and N. Ye. Zimin and D. M. Sonechkin, USSR Hydrometeorological Scientific Research Center]

[Abstract] The most popular long-range forecasting method is based on the "analogue" principle, but in actuality the validity of this forecasting technique has never been validated. In order to clarify and rectify this matter, on the basis of the concepts of the mathematical theory of dynamic systems a rigorous formulation is given for the problem of long-range forecasting on the basis of long-term archives and the accuracy attainable in such forecasts is evaluated. A specific scheme for forecasting the field of mean monthly air temperature for the territory of the USSR and non-Russian Europe is outlined. It is believed that the proposed long-range forecasting method, based on archival data, despite certain reservations, can advantageously replace subjective synoptic long-range forecasts until hydrodynamic long-range forecasting methods are developed. The method could easily be extended to two- and three-month (seasonal) forecasts of the temperature field, to the corresponding surface pressure fields and also the fields of 1-3- month precipitation sums, for which representative archives have been accumulated (at least for the 20th Century). Figure 1; references 5: 1 Russian, 4 Western

Ozone Variations Over Antarctica in 1987-1988

[Article by Ye. A. Zhadin, candidate of physical and mathematical sciences, and V. N. Ferletskiy, Central Aerological Observatory]

[Abstract] Data from balloon observations were used in examining changes in the total content and concentration of ozone at several Antarctic stations during the periods August-November 1987 and 1988. An analysis of data for Halley Bay and Amundsen-Scott stations indicated that the decrease in the total content and concentration of the ozone at the maximum begins virtually simultaneously in late August-early September at these Antarctic stations. This is not consistent with the corollaries of the hypotheses of formation of the ozone "hole" in Antarctica relating the time of its appearance to reappearance of the sun after the polar antarctic night. In September-October 1988 high ozone contents were observed in Antarctica in comparison with 1987 and this may be related to the quasibiennial cycle of the zonal wind near the equator. A simple mechanism of generation of the quasibiennial cycle in the high latitudes of the northern and southern hemispheres is proposed. The mechanism of formation of quasibiennial variations of ozone and temperature may be attributable to reflection of planetary waves from the equatorial line of the zonal wind. Wave activity in the stratosphere is a superposition of incident and reflected planetary waves. Planetary waves strongly dissipate in the equatorial zone. With a westerly phase of the quasibiennial variation the double

passage of reflected planetary waves across the equator weakens the total wave activity in the high-latitude stratosphere in the northern hemisphere winter and in the southern hemisphere spring. With an easterly phase the waves reflected from the equatorial critical line can lead to frequent stratospheric warmings and an increase in total ozone content. Figures 4; references 13: 2 Russian, 11 Western.

UDC 551.583

Estimating Global Atmospheric Surface Layer Temperature

[Article by O. A. Drozdov, Yu. Yu. Gubanova and G. I. Mosolova, Leningrad State University]

[Abstract] Different reconstructions of changes in northern hemisphere surface air temperature are compared. A critical review of the literature reveals that when using reconstructions for evaluating the state of climatic systems and trends in change in these systems the material used in the reconstruction is a highly important consideration. Although there is a great closeness of the correlation between different reconstructions (correlation coefficient 0.95), in individual decades the differences between temperature deviations of the surface air layer may attain 0.1°C. This value is of the same order of magnitude as the predicted air temperature change to the end of the century. The secular variation of interlatitudinal temperature gradients corresponds to the variation in global temperature. However, with rapid warming or cooling there is a lag in the restructuring of interlatitudinal temperature contrasts in comparison with the variation in global temperature. This becomes systematic with rapid anthropogenic warming. References 12: 10 Russian, 2 Western.

UDC 551.465.4(269)

Dynamics of Zonal Flows in Ocean

907N0179B Moscow DOKLADY AKADEMII NAUK
SSSR in Russian Vol 313 No 3, Jul 90 (manuscript
received 17 Jul 89) pp 705-710)

[Article by D. O. Wolff, V. O. Ivchenko, A. V. Klepikov
and D. Olbers, Max Planck Meteorology Institute, Ham-
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Research Institute, Leningrad; Wegener Polar and
Marine Research Institute, Bremerhaven, West Ger-
many]

[Abstract] Eddy disturbances, primarily of a synoptic
scale, play a special role in the dynamics of zonal flows
responsible for meridional exchange of properties. A
study was made of the dynamics of zonal flows using
theoretical considerations and an analysis of eddy-
resolving numerical experiments. All the theoretical con-
structions and experimental work were based on a quasi-
geostrophic approximation for a two-layer flow in a
channel. The boundary conditions used in eddy-
resolving experiments in this channel were as formulated
by McWilliams. Numerical experiments were carried out
in a channel 1500 m wide and 4000 m long. The
southern boundary was the simulated idealized shores of
Antarctica. Depth of upper layer 1000 m; depth of lower
layer 4000 m; horizontal grid interval 20 km. The
experiments were continued until all the parameters
were statistically stabilized (22-33 years model time).
Numerical experiments were carried out for a channel
with a flat bottom for easterly and westerly directed
flows, important for understanding differences in eddy
dynamics of flows of different directions. The principal
differences observed in the easterly and westerly exper-
iments are discussed. For example, in the balance of
zonal momentum in the easterly experiment a substan-
tial contribution is made by the divergence of Reynolds
eddy stresses, whereas in the westerly experiments the
contribution of Reynolds stresses to the balance of zonal
momentum is close to zero, explaining absence of a
concentration of momentum. Further results of research
along these lines by the same authors is given in DOK-
LADY AN SSSR, Vol 313, No 4, pp 970-974, 1990.
Figures 2; references 12: 6 Russian, 6 Western.

UDC 551.465.4.(269)

Influence of Topography on Dynamics of Zonal Flows in Ocean

917N0002A Moscow DOKLADY AKADEMII NAUK
SSSR in Russian Vol 313 No 4, Aug 90 (manuscript
received 21 Aug 89) pp 970-974

[Article by J. O. Wolff, V. O. Ivchenko, A. V. Klepikov
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Marine Research Institute, Bremerhaven, West Ger-
many]

[Abstract] This article is essentially a continuation of the
research published by the authors in the preceding issue
of this same journal (DAN, Vol 313, No 3, pp 705-710,
1990). Bottom relief considerably changes the dynamics
of zonal flows and a countercurrent may develop in the
bottom layers. The influence of such relief was investi-
gated within the framework of a two-layer quasigeo-
strophic model. A series of numerical experiments with
such an eddy-resolving model was carried out for a
zonally oriented two-layer channel (length 4000 km,
width 1500 km, central line of basin corresponding to
latitude 60 degrees S, southern boundary simulating the
idealized shores of Antarctica; thickness of upper layer
1000 m, lower layer 4000 m; grid interval 20 km.)
Bottom relief was stipulated in the form of a single rise of
Gaussian shape with a height 500 m drawn out 300 km
in a meridional direction and a depression symmetric to
the mentioned rise. Four experiments were carried out
for westerly and easterly directed flows: easterly, rise at
center; easterly, rise displaced northward; westerly, rise
displaced southward; easterly, depression displaced
southward. In the easterly flow there was a strong eddy
regime, a group of eddy formations of a synoptic scale
and meandering jets, whereas in the westerly flow the
picture was completely different, the reserves of avail-
able potential energy being less by a factor of 3 than in
the easterly flow (a "wave" instead of an "eddy" regime,
the stream function field in a statistically stationary
regime at an arbitrary moment in time consists of
low-amplitude waves and no well-developed eddies are
observed). A distinctive feature of easterly flow is the
formation of an anticyclonic Taylor eddy over a rise, but
downstream this is observed to the north of the rise.
Another important feature of easterly flow is the splitting
of the current into jets. Figures 3; references 7: 4 Rus-
sian, 3 Western.

UDC 551.463.21

Bottom Region of Sharp Reduction in Intensity of Oceanic Noise Under Cold Oceanic Eddy

907N0179C Moscow DOKLADY AKADEMII NAUK
SSSR in Russian Vol 313 No 3, Jul 90 (manuscript
received 2 Nov 89) pp 711-715

[Article by B. I. Klyachin, Oceanology Institute imeni P.
P. Shirshov, USSR Academy of Sciences, Moscow]

[Abstract] An eddy exerts an influence on the field of
oceanic noise generated at its surface. Most of the noise
energy of a horizontally homogeneous ocean is concen-
trated in water rays. In a cold eddy the minimum of the
speed of sound is less than the minimum of the speed of
sound in the medium surrounding the eddy. The eddy
"draws" sound rays into the region near the axis of the
underwater sound channel. A region of sharp decrease in
noise intensity is formed within the eddy beneath the

horizon of rotation of the steepest water ray. These factors are taken into account in a study of the sharp reduction in the intensity of oceanic noise beneath such a cold eddy. The problem is formulated with a series of assumptions. The specific objective of the study is to determine how the noise field of a layered medium is transformed with penetration within the eddy and in the region behind the eddy. Expressions are derived for the ray invariant of the theory of radiation transfer in a layered medium, for the noise field within a selected eddy section and for the volume density of energy. These and other expressions make it possible to solve the formulated problem within the limits of the assumptions made. Specific computations are made using a bilinear approximation for the speed of sound inside and outside the eddy. Significant conclusions are drawn on the basis of these computations. Figures 2; references 10: 8 Russian, 2 Western

UDC 551.465

Variability of the Benthic Layer of the Pacific Ocean in a Region of Development of Iron-Manganese Nodules

[Article by T. A. Demidova, Ye. A. Kontar, A. M. Belyayev, and I. I. Soltanovskiy, Shirshov Institute of Oceanology, USSR Academy of Sciences]

[Abstract] Studies are being conducted to determine the factors that control the formation of mineral deposits, in particular, iron-manganese nodules, on the ocean bottom. It is known that benthic currents play a decisive role in virtually all benthic processes. For the most part, the hydrodynamic characteristics of this layer have mainly been studied only indirectly or in isolated areas. Among the prominent experiments that have been conducted are HEBBLE, DOMES, and MANOP. This article discusses a study of ocean floor currents conducted near Clipperton Island and the Guatemala basin. This study includes probing of the bottom and a study of temperature and current using the POTOK instrument system. One station was in a valley at a depth of 4920 m, the other was on a plain at a depth of 3715 m. Data analysis techniques are described, including spectral analysis. All spectra contained inertial, diurnal, and semidiurnal cycles. Analysis is focused on only one site. The average current velocity was found to be 1.6 cm/s. The spatial scale of mass transfer in the period of observation was about 50 km, and water shifted in a pulsating manner. The threshold current velocity for erosion, mass transfer, and redistribution of sediments are discussed. Probing of the bottom revealed varying concentrations of iron-manganese nodules from 0-12 kg/m². The second site revealed sedimentation of very fine material. Figures 7; references 21: 10 Russian 11 Western

UDC 551.466

Propagation of Airy and Fresnel Internal Waves in Nonstationary Media

[Article by V. V. Bulatov and Yu. V. Vladimirov, Mechanical Problems Institute, USSR Academy of Sciences, Moscow]

[Abstract] A method proposed earlier by the same authors ("traveling waves method") (MOR. GIDROFIZ ZHUR., No 6, pp 14-19, 1989) was used in solving the problem of propagation of Airy and Fresnel internal waves in a vertically stratified nonstationary medium. Airy and Fresnel waves are generated during movement of a source in a layer of stratified fluid with different types of N^2 distribution, nondependent on time. An eikonal equation was derived for determining the position of wave fronts. Conservation laws were found making it possible to determine the evolution of the width and amplitude of the waves with time. It was found that temporal variability of the Brunt-Vaisala frequency can exert a considerable influence on the nature of propagation of internal waves. Accordingly, when solving problems relating to internal wave propagation the temporal variability of the Brunt-Vaisala frequency must be taken into account in addition to vertical stratification and the dependence of N^2 on horizontal variables. Figures 3; references: 6 Russian

UDC 551.463.228

Influence of Wind and Internal Waves on Parameters of Oceanic Noise

[Article by A. A. Aredov, G. M. Dronov and A. V. Furduyev, Acoustics Institute imeni N. N. Andreyev, USSR Academy of Sciences]

[Abstract] An experiment was carried out in the open ocean for determining the correlation between the characteristics of intrinsic noise in the ocean, wind speed and the amplitude of an internal wave. Observations were made from a research ship in an area with a typical tropical speed-of-sound profile with an underwater sound channel at a depth of about 1000 m, a thermocline at a depth 160-200 m and a speed of sound at the bottom (about 5000 m) slightly exceeding the speed of sound at the surface. During the experiment there was registry of wind speed and position and thickness of sound scattering layers during a period of absence of noise-generating ship traffic or squalls. Surface waves, speed-of-sound profile and spectrum of internal waves at the thermocline horizon also were registered. Analysis of all

these data revealed that the spectral values of acoustic noise pressure are determined by a power function of the wind with an exponent about 1.3 for reception by a nondirectional hydrophone. The possibility of detecting an internal wave by a horizontally directed antenna on the basis of fluctuations of the spectral components of ocean noise is therefore experimentally confirmed. Figures 3; references 11: 8 Russian, 3 Western.

Analytical Model of Dynamics of Arctic Eddy Lens

[Article by Ye. V. Zharnitskiy, Arctic and Antarctic Scientific Research Institute, Leningrad]

[Abstract] An estimate of the Kibel number for an arctic intrathermocline eddy indicated that a substantial influence is exerted by inertia. A model is proposed for describing the movement of a symmetric homogeneous lens in a two-layer ocean, not making use of the quasi-geostrophic approximation. On the basis of the Lagrange approach a precise analytical solution of the equations of dynamics describing the periodic reciprocal transfer of kinetic energy and part of the available potential energy is given. Rotation of the lens in general is anticyclonic. The law of increase in radius under the influence of a small linear trend on the boundary corresponds qualitatively to experimental data. Such computations are illustrated for a specific case showing that the lens radius varies from 15 to 18 km and the thickness from 200 to 140 m with the azimuthal component of velocity varying from 0 to 32 cm/s and the radial component varying from 0 to 20 cm/s. Available potential energy and kinetic energy also are calculated. Figures 2; references 14: 5 Russian, 9 Western.

Theoretical and Laboratory Research on Thermal Bar

[Article by S. S. Zilitinkevich and K. D. Kreyman, Limnology Institute, USSR Academy of Sciences, Leningrad]

[Abstract] This is essentially a continuation of earlier studies by these authors (OKEANOLOGIYA, Vol 27, No 5, pp 732-738, 1987; No 5, pp 755-758, 1989) and by K. D. Kreyman (OKEANOLOGIYA, Vol 29, No 6, pp 935- 938, 1989). A thermal bar is a phenomenon of fresh-water lakes and seas of low salinity, such as the

Gulf of Finland. Its experimental investigation in natural water bodies requires extensive and costly expeditionary work. Although laboratory simulation of a thermal bar would be highly desirable, thermal bars in the laboratory and in a natural water body are phenomena of a different nature. An effort was made to determine whether there is a real possibility for reproducing a thermal bar in the laboratory and if so, how to distinguish periods with laminar and turbulent modes, without knowing which no realistic simulation is feasible. Laboratory experiments were carried out in 1988 using apparatus described in the mentioned Kreyman article. Both the mentioned questions were answered affirmatively. However, a number of problems remain to be solved: it is necessary to determine the critical value of the Rayleigh number for a thermal bar and it is necessary to ascertain the value of the highly important universal constant C_1 more precisely. This will require experiments in large wedge-shaped basins with a depth of 25-30 cm. Figures 3; references 6: 5 Russian, 1 Western.

Monte Carlo Simulation of Small-Scale Turbulence and Its Measurements in Ocean

[Article by V. S. Maderich and I. Yu. Avdeyeva, Hydromechanics Institute, Ukrainian Academy of Sciences, Kiev]

[Abstract] Simulative modeling of an ensemble of turbulent spots was carried out by the Monte Carlo method. An arbitrary but quite large region outside the boundary layers is defined in which turbulent spots of different size and intensity randomly are generated and evolve under the influence of shear currents. A simple integral mathematical model is proposed for describing the principal stages in evolution with time, determined by turbulent entrainment and gravitational spreading of three-dimensional spots. The model was constructed by averaging the equations of a semi-empirical model of turbulence for the volume of a spot on the assumption of locally constant stratifications with a given Vaisala frequency and currents with a stipulated vertical gradient. It was found that the principal source for maintaining a statistically stationary state of turbulence is the generation of new spots. Most of the dissipation (52%) is concentrated in 3% of the number of turbulent spots. A short lifetime of turbulence in spots results in intermittence and a dissipation rate lognormal distribution function. Figures 3; references 16: 10 Russian, 6 Western.

Wave Mechanism of Seasonal Variability of Large-Scale Field of Currents in Tropical North Atlantic

[Article by G. K. Korotayev and G. A. Chepurin, Marine Hydrophysics Institute, Sevastopol]

[Abstract] A mechanism of adaptation of the large-scale field of currents in the Tropical North Atlantic to seasonal changes of wind due to planetary Rossby waves is examined. First the main features of seasonal variability in this region are described on the basis of data in the literature and expeditionary data obtained under the "Razrezy" program. A spectral maximum corresponding to the first baroclinic mode of the planetary Rossby wave is investigated and it is shown that the seasonal restructuring of large-scale circulation of the field of currents is associated with propagation of this wave. Then a simple quasigeostrophic model of the seasonal restructuring of the field of currents is proposed taking into account only the first baroclinic mode of Rossby waves and problems related to its applicability are discussed. This model is employed in computations based on the climatic wind field and the computation results are compared with experimental data. The possibility of heat transport from the tropics into the northwestern part in the spring by a "locking" mechanism is postulated and this process is illustrated by data from an experiment carried out in the northwestern part of the Tropical Atlantic in 1989. Figures 6; references 19: 8 Russian, 11 Western.

Possibility and Some Results of Acoustic Mapping of Ocean Floor

[Article by A. V. Bunchuk, V. I. Volovov and D. A. Zharinov, Acoustics Institute imeni N. N. Andreyev, USSR Academy of Sciences]

[Abstract] Work was carried out in 1987 in the central part of the Indian Ocean with a hilly bottom and depths about 5000 m in a test range measuring 25 x 25 km for determining the properties of the spatial variability of a series of parameters of the reflected acoustic signal (mean normalized amplitude, correlation radius and variation of small- scale amplitude fluctuations). The ship moved along a system of parallel and perpendicular runs at 10 knots. The registered data were computer-processed on shipboard. The spatial and temporal stability of these parameters were determined (amplitude 20 db, correlation radius 5-60 cm, variation 10-80%). There was a considerable spatial variability but a high temporal stability. This made it possible to reference the parameters of the reflected signal to geographical coordinates and represent this variability in the horizontal plane in the form of isoline maps. The computer-generated maps are discussed. Maps constructed for each of the parameters of the signal reflected from the bottom for a part of the investigated test range measuring 6 x 6 miles are presented as examples of the possibilities of the method. Such maps confirm the possibility of mapping the ocean floor in limited areas by making use of several parameters of signals reflected from the floor with a detail superior to that previously attainable. Figures 4; references 14: 13 Russian, 1 Western.

Mesoscale Variability of Hydrophysical Fields of Canaries Upwelling Determined From Shipboard and Satellite Observations

[Article by A. G. Kostyanoy, G. A. Redkin and Yu. V. Stepanov, Oceanology Institute imeni P. P. Shirshov, USSR Academy of Sciences, Moscow; Atlantic Scientific Research Institute for Fisheries and Oceanography, Kaliningrad]

[Abstract] Hydrophysical investigations of the Canaries upwelling, carried out on the "Monokristall" research ship in February 1987, made it possible to determine the position of centers with upwelling of cold waters to the ocean surface, to describe the evolution of the transverse jet transporting colder upwelling waters in the direction of the open ocean for a distance of 80 km and to detect an intrathermocline eddy with a diameter 35 km and a thickness 200 m. An analysis of hydrological archival data revealed other cases of detection of intrathermocline and near-bottom lenses in the neighborhood of the Canaries upwelling and provided their principal characteristics. It is postulated that intrathermocline lenses are formed as a result of geostrophic adaptation of homogeneous near-bottom lenses forming on the shelf due to intensive mixing in the near-bottom layer during an "upwelling" event. In this general region there is a high mesoscale dynamic variability of hydrophysical fields caused by a complex system of currents, discrete-continuous rising of waters to the surface, formation of a characteristic spotty structure of surface waters, surface and subsurface eddies and transverse jets. All these mesoscale eddy formations are of great importance for the fishing industry. Figures 3; references 21: 7 Russian, 14 Western.

Chemical Composition and Origin of Oceanic Ore-Forming Thermal Springs

[Article by S. G. Krasnov and S. M. Sudarikov, All-Union Scientific Research Institute for Oceanology, USSR Ministry of Geology; Sevmorgeologiya Geological Production Association]

[Abstract] This is a general review of the Soviet and foreign literature on the nature of thermal springs on the ocean floor. High-temperature varieties of thermal springs forming sulfide ores in oceanic and intercontinental rifts and rifts behind arcs are almost completely deprived of magnesium and the sulfate ion and are greatly enriched with ore elements. In coastal submarine and subaerial springs in regions of active ocean margins and in the neighborhood of Iceland mixtures of these thermal waters and cold sea water have been examined in detail. Brines of the Red Sea depression were formed due the presence of thermal springs which dissolve salts on the Red Sea floor. In island arc regions near active volcanoes in some coastal submarine sectors there are sulfide-forming thermal springs of a different type. Oceanic thermal springs with a sodium chloride composition are formed as a result of high-temperature interaction between sea water and bottom rocks when there is convection along fissured zones in the oceanic crust. The small admixture of magmatic fluids present in thermal springs of oceanic rifts exerts no significant influence on the salt composition and metal content of these thermal waters. Thermal springs of the same type located in marginal oceanic regions, where magmas are more water-saturated, may contain a more considerable (although difficult to estimate) fraction of magmatic water. Together with thermal springs on the land, forming polymetallic sulfide mineralization, the ore-forming thermal springs of the ocean, regardless of their genesis, can be ranked in a general series with regularly changing acidity and salinity. These characteristics of solutions, determining their possibilities with respect to the leaching out and transport of ore components, play a key role in formation of hydrothermal-sedimentary sulfide ores. Figures 2; references 53: 21 Russian, 32 Western.

Three-Dimensional Acoustic Waveguide in Labrador Sea

[Article by K. T. Bogdanov and O. V. Artemyev, Pacific Ocean Oceanological Institute, Far Eastern Department, USSR Academy of Sciences, Vladivostok]

[Abstract] Homogeneous regions with relatively low temperature and salinity are present on the continental shelf and slope of the Labrador Sea. These regions are associated with the cold and freshened axes of the Labrador and West Greenland Currents and are outlined by isotachs of the speed of sound and bottom relief. The existence of the lateral boundary of the waveguide in the direction of the sea is a result of the character of the temperature and salinity gradients in the polar front zone. The other boundary of the waveguide is the shore and continental slope of the Labrador Peninsula and Greenland. The formation of the upper boundary of the waveguide with vertical speed-of-sound gradients up to 1.5 s^{-1} occurs due to heating of the sea surface during summer. During winter the upper boundary of the waveguide is the sea surface. All this gives rise to conditions for the formation of the observed three-dimensional acoustic waveguide with a nucleus lying at depths 50-200 m. The extent of the three-dimensional waveguide corresponds to the extent of the currents. The mentioned features are thus related to the physical characteristics of the polar front and seasonal thermal processes in the Laborador Sea. Figures 2; references 6: 4 Russian, 2 Western.

Influence of Spatial Inhomogeneity and Temporal Instability of Upper Layer of Ocean on Acoustic Fields in Near Zone

[Article by N. A. Vasilyev, Acoustics Institute imeni N. N. Andreyev, USSR Academy of Sciences]

[Abstract] Observations made from a research ship at anchor or at drift using pseudostationary hydroacoustic paths revealed slow changes in the levels of the received signals. The distance from the source lowered from the ship to a vertical string of receiving hydrophones varied from 1000 to 3500 m. The slow changes in the levels of the received signals at some hydrophones attained 5-6 db. The period of such variations was 7-12 minutes. These level variations could not be attributed to the interference of individual rays due to any change in the length of the formed paths. Although the length of the path did change somewhat during the experiment, this was too small to cause interference. Four experiments were carried out (2 in the Pacific Ocean and 1 each in the Philippine Sea and in the Indian Ocean). In all four cases the results confirmed the hypothesis that the slow change in signal levels registered by individual hydrophones was caused by the spatial-temporal structure of the upper ocean layer. The results obtained in different parts of the world ocean show that for specific conditions of relative arrangement of source and receiver it is possible to expect slow changes in the level of the received signals attributable to spatial inhomogeneity and temporal

instability of the upper ocean layer. This method, using pseudostationary paths, may be useful in studying internal waves. Figures 2

Influence of Wind Waves on Waveguide Propagation of Sound in Ocean

[Article by A. V. Belousov and Yu. P. Lysanov, Acoustics Institute imeni N. N. Andreyev, USSR Academy of Sciences]

[Abstract] In an earlier article (AKUST. ZHURN., Vol 33, No 5, pp 814-820, 1987) the authors developed a method for computing the incoherent component of the multiply scattered acoustic field in a near-surface channel in the ocean when there are small waves on the surface (simulated by small-scale irregularities with a Gaussian correlation coefficient). In this article the empirical Pierson-Moskovitz spectrum, which most adequately characterizes real wind waves, is used. As a result of multiple contacts between acoustic waves and the irregular ocean surface most of the scattered energy leaves the near-surface channel. The incoherent energy trapped by the channel is concentrated within ray tubes formed by the rays. This effect is manifested especially clearly in the case of a "thin" (depth to 1 km) near-surface channel when the limiting glancing angle does not exceed several degrees. Due to the smallness of the Rayleigh parameter the part of the energy trapped by the near-surface channel in a single scattering event is small. These and other findings provide a basis for comparing the results of computations of the scattered acoustic field with experimental data. An experiment was carried out in a "linear" near-surface channel with a depth 88 m. The sound source used was a nondirectional monochromatic source lowered to a depth of 17 m. Measurement data were registered at 1030 Hz with a reception depth 71 m. An analysis of this experiment revealed that in the interpretation of such measurements it is the form of the real scattering phase function which is of the greatest importance. Figure 1; references 5: 3 Russian, 2 Western.

Advective Transport of Dynamically Passive Admixtures by Baroclinic Singular Geostrophic Eddies in Atmosphere (Ocean)

[Article by V. M. Gryanik and T. N. Doronina, Atmospheric Physics Institute, USSR Academy of Sciences]

[Abstract] A study was made of the regularities of advective transport of dynamically passive admixtures by large-scale currents and localized eddies in a stratified rapidly rotating fluid. At synoptic space-time scales currents and localized eddies are described in a quasi-geostrophic approximation. Emphasis is on research on elementary interaction events in the field of an admixture with localized baroclinic eddies: formation of spiral admixture structures in the eddy field, scattering and blocking of the admixture by quasistationary and non-stationary eddy structures and transport of an admixture trapped by eddies. A classification of dynamic regimes of transport of such an admixture by eddies is given. The principal mechanisms of joint influence of a solitary eddy and a flow with shear velocity on the admixture field are investigated (axisymmetrization, scattering, transport). The results reveal one of the possible mechanisms for pollution of the Arctic by aerosol and other admixtures as a result of blocking of cyclonic flow by the stationary Siberian anticyclone and the transport of admixture by moving cyclones and anticyclones. Various possible applications of the theory of advective transport examined in this article are discussed. Figures 5; references 17: 12 Russian, 5 Western.

Nonlinear Two-Dimensional Internal Waves Generated by Periodically Operative Source in Exponentially Stratified Medium

[Article by A. V. Kistovich, V. I. Neklyudov and Yu. D. Chashechkin, Mechanical Problems Institute, USSR Academy of Sciences]

[Abstract] A theoretical and experimental study was made of the nonlinear properties of two-dimensional beams of internal waves of finite amplitude generated by a periodically operative source in an exponentially stratified fluid without making use of the Boussinesq approximation. The computations and measurements discussed in the article show that nonlinear (anharmonic) waves are the principal form of propagation of wave disturbances in a stratified medium. In an exponentially stratified medium there is an accentuation of the crests and a flattening-out of the troughs. The amplitude and number of harmonics increase with an increase in the amplitude of source oscillations. A wave of the fundamental frequency and its harmonics are propagated at the same angle to the horizon, including with impairment of the condition for the existence of linear waves in an exponentially stratified medium. The results of the computations and experiments qualitatively and quantitatively coincide. Similar anharmonism effects are observed for internal waves under oceanic conditions. Figures 3; references 16: 11 Russian, 5 Western.

UDC 551 446 3

Large-Scale Wave Disturbances in Ocean Surface Temperature Field

[Article by T. V. Belonenko and D. K. Staritsyn, Leningrad State University]

[Abstract] Intramonthly fluctuations in the field of ocean surface temperature with characteristic spatial scales from tens to hundreds of kilometers are governed for the most part by large-scale interaction between the atmosphere and ocean, but without question wave processes also exert an influence on the existence of temperature anomalies. In the mentioned scale range there are virtually no representative data on currents, but the parameters of wave processes can be estimated using data on variability of the water temperature field. Such data were collected by remote (aircraft) IR measurements made in the summer-autumn of 1983, 1984 and 1986 in the South Kuril region and were used in compiling ocean surface temperature maps. The maps revealed temperature inhomogeneities with mean velocities of movement about 20-40 cm/s. The directional movement of such inhomogeneities is evidently related to the generation of free shelf waves in this region, although Rossby waves also exert a definite influence. The spatial scales of these Rossby and shelf waves were investigated. Estimates of the spatial scales and phase velocities for both Rossby and shelf waves are commensurable with the scales and velocities of movement of temperature inhomogeneities. Figures 3; references: 7 Russian.

UDC 551.521.3

Radiation Field in Depth of Semi-Infinite Turbid Medium Containing Monodirectional Point Source

[Article by N. N. Rogovtsov, Belorussian Polytechnic Institute]

[Abstract] An asymptotic expression is derived for the intensity of radiation at a great optical depth in a homogeneous semi-infinite turbid medium bounded by a mirror-reflecting surface and containing a monodirectional stationary point source without additional limitations on the position of the observation point or any other significant assumptions concerning the characteristics of an elementary volume. No assumptions are made concerning the structure of the radiation field; it is only assumed that the scattering phase function is continuous. A significant limitation, medium homogeneity, is partially removed at the end of the article when seeking an asymptotic form of the radiation field in a two-layer medium. It is noted that problems relating to the finding of rigorous asymptotic solutions of the transfer equation for media irradiated by narrow beams have virtually never been examined in the literature. The results are of independent interest but also can be used in checking the applicability of approximate methods. Figure 1; references 25: 24 Russian, 1 Western

UDC 551 463.5

Sun Glitter Scintillations on Sea Surface

[Article by I. G. Yakushkin, Atmospheric Physics Institute, USSR Academy of Sciences]

[Abstract] Earlier results are used in describing brightness fluctuations of the sun glitter created on the sea surface by a source of small angular dimensions. Specifically, an analytical description is given for the second moment of intensity in the sun glitter image arising with illumination of the sea surface by an incoherent source of small but finite angular dimensions. Various statistical models of the surface are considered. The dependence of dispersion and the correlation function of intensity fluctuations on the properties of surface waves, optical system parameters and distance between the observed sector and the center of the glitter is investigated. The possibility of determining surface parameters on the basis of the observed parameters is discussed and the method is illustrated by numerical computations. Specific expressions are derived which can be used for determining wave spectrum parameters from the sun glitter under various conditions. Figures 2; references 16: 13 Russian, 3 Western.

UDC 550.837.211

Electromagnetic Sounding of Ocean Floor Using A Priori Information

[Article by L. L. Vanyan]

[Abstract] The equation $H_x - H_z = i$ (1) makes it possible to find the electrical field in the water $E = i/S$ and bottom impedance: $Z = S^{-1}(H_z/H_x -1)$ (2). The error in determining the frequency characteristic of impedance is dependent primarily on the error in harmonic analysis of irregular geonmagnetic variations. It is aggravated by the structure of formula (2). The error of the difference entering into the expression for impedance (2) increases by several times in comparison with the error of the

H/H, ratio, reducing the information yield from sounding. One of the methods for increasing the accuracy of electromagnetic sounding is the use of a priori information. In part this is already taken into account in formula (2) in the form of information on integral conductivity of the water layer. This can be supplemented by a priori information on the deep geoelectric section. Apparent resistivity at the ocean surface can be used as a priori information, and on this basis a formula is derived for apparent resistivity at the bottom. This is illustrated for the case of electromagnetic sounding in the Juan de Fuca region. Computations of bottom impedance made using formula (2) require use of both the amplitude and phase characteristics of the ratio of magnetic fields at the bottom and at the surface. The proposed method, on the other hand, uses only amplitude data, characterized by greater stability. Figure 1; references 4: 3 Russian, 1 Western.

UDC 551.46

Strong Currents in Ocean Depths

[Article by B. L. Gavrilin, A. S. Monin, corresponding member, USSR Academy of Sciences, and A. D. Yampolskiy, Oceanology Institute imeni P. P. Shirshov, USSR Academy of Sciences, Moscow]

[Abstract] Rather strong nonstationary currents with velocities at times greater than 30 cm/s were discovered on the 38th cruise of the "Akademik Vernadskiy" in December 1988 in the Guiana Basin using automatic buoy stations at a depth 4000 m (700 m above the ocean floor) in an area where there are no special bottom relief features favoring the appearance of strong currents. For further study of this phenomenon 5 automatic buoy stations were positioned about 10 miles apart across the general current with current meters lowered to depths 40, 100, 200, 700 and 4000 m. An extensive file of registered data gives the impression of strong variability of currents with depth and time, different for different buoy stations despite their close positioning, but with a virtually identical temperature profile. A further analysis of the materials shows that at great depths in the ocean at certain times and in certain places there can be strong currents (most frequently nonstationary, but also quasistationary), "cascades" of heavy waters pouring across underwater sills. The latitudes at which the inertial period is commensurable with one of the periods of the main tides may be favorable locations for this phenomenon and syzygies may be favorable times for its observation. Figure 1; references: 8 Russian.

Long-Range Surface Reverberation of Sound in the Ocean

[Article by V. S. Averbakh, L. F. Bondar, V. N. Golubev, V. Yu. Goldblam, L. S. Dolin, A. G. Nechayev, K. Ye. Pigalov, G. Ye. Smirnov, and Ye. I. Tumayev, Institute of Applied Physics, USSR Academy of Sciences]

[Abstract] In an acoustic experiment conducted in Feb-Mar 1989, the research ship "Akademik Aleksandr Vinogradov," while drifting in the shelf zone, emitted tone-pulse signals into the surface sound channel to investigate sound reverberation. Parameters of the experiment were: drift speed 0.5-1.2 m/s; pulse duration 128 s, repetition period 1024 s, frequency 228 Hz; depth of sound emitter 40 m; surface wind speed 10-15 m/s. Analysis of energy spectra obtained reveal, besides lines at the frequency of the sounding signal (bottom reverberation), surface reverberation lines, somewhat displaced in frequency. Further analysis shows a correlation effect in the levels of the surface and bottom reverberations, evidenced by bursts of surface reverberations at the time when strong reflections from large-scale irregularities in the bottom topography occur. This correlation facilitates observations of the surface reverberations. The effect is believed to be caused by inclined sectors of the ocean floor, which simultaneously as the bottom reverberation is being formed, increase the slip angle of the beam incident on the surface after reflection from the bottom. This increases the acoustics of the sea surface, resulting in a higher surface reverberation level. Figures 2, references 4 (Russian).

Mesoscale Variability of Storm Wind Speeds Over the Seas

[Article by V. N. Bokov, Leningrad Division of the State Oceanographic Institute]

[Abstract] Spectral estimates of wind speed in the mesoscale variability range have been obtained on the basis of continuous recordings of high and gale winds made at sea and onshore. Emphasis in this study is on the interval characterizing the structure of winds of less than 3 hours. To measure the spectral structure of winds in the mesoscale range for each part of the cyclone (forward, warm, and rear sectors), continuous recordings (using the M-63M-1M fast-response anemorhumb meter) of high and gale wind speeds, made aboard the research ship "Rudolf Samoylovich" in the Baltic Sea in 1989-88, were used. Specific forms of the spectrum, caused by convective instability of the atmosphere, are found to correspond to certain parts of the cyclonic field. In high wind zones, in adjacent sectors of cyclones and anticyclones, the mesoscale disturbances are caused by gravity waves. For the rear part of the cyclone, the dependence of the wind speed spectrum on its module values and

atmospheric stratification is defined. Differences between measured and calculated values of the driving wind are explained on the basis of data obtained. In conclusion, it was found that failure to take mesoscale variability into account in calculating oceanological characteristics, using wind speed and dynamic speed, results in large errors in determining these characteristics. Author thanks L. I. Lopatukhin, doctor of geographical sciences, for his assistance. Figures 2, tables 3, references 22: 16 Russian.

Formation of the Water Temperature Field of the Ocean Surface in the Energy-Active Zone of the Northwestern Pacific Ocean as Exemplified by the "Megapoligon" Experimental Range

917N0048C Moscow METEOROLOGIYA I GIDROLOGIYA in Russian No 11, Nov 90 pp 70-77

[Article by V. I. Byshev, candidate of physical and mathematical sciences and V. G. Snopkov, candidate of geographical sciences, Institute of Oceanology]

[Abstract] Processes involved in the formation of temperature fields and temperature field anomalies were studied on the basis of the interdepartmental hydrophysical expedition "Megapoligon," conducted in the energy-active zone of the northwestern Pacific, east of Japan, in July-October 1987. Japanese temperature field variability charts were compared with Soviet findings at sea. The role of the heat budget and heat advection were evaluated, where heat advection was examined as the resultant of the contributions of the drift component, mesoscale and synoptic currents, and the average heat transfer. Combined analysis of current and temperature fields showed that water temperature variability, caused by mesoscale and synoptic eddies, amount to 6-8°C and more, while correlation of temperature and current changes for these scales reached 0.8 and more. It is concluded that the temperature field variability in the experimental range is caused chiefly by two equally important factors—drift currents and eddy activity (mesoscale and synoptic eddies), while the heat budget is less important. Figures 2, tables 3, references 8 (Russian).

Surface Tension Coefficient for Ocean Water

917N0048E Moscow METEOROLOGIYA I GIDROLOGIYA in Russian No 11, Nov 90 pp 108-109

[Article by V. B. Lapshin, candidate of physical and mathematical sciences, and I. G. Ragulin, State Oceanographic Institute]

[Abstract] In the summer of 1988, the research ship "Georgiy Ushakov," among other things, investigated the surface properties of ocean water samples taken from the surface microlayer of the Atlantic. Measurements of the surface tension were made by the method of maximum pressure in a bubble. An anomalous dependence of the surface tension coefficient on temperature was found to exist and was confirmed by both investigations in the Equatorial Atlantic as well as by measurements under laboratory conditions. However, the phenomenon of spasmodic inverse change of surface tension detected in water samples taken from the surface microlayer requires further study. Figures 1, references 4 (Russian).

Investigation of the Parameters of Distribution of the Empiric Functions of Extreme Wave Heights

917N0048F Moscow METEOROLOGIYA I GIDROLOGIYA in Russian No 11, Nov 90 pp 109-112

[Article by V. B. Korobov, candidate of geographical sciences, Northern Territorial Administration for Hydrometeorology]

[Abstract] Calculated wave heights as a function of the selection of the procedure for evaluating the distribution parameters is examined on the basis of analysis of synoptic charts of the White Sea extending over a period of 35 years. In approximating the empiric distribution functions of wind wave parameters by means of the theoretical laws of distribution, the calculated wave heights, which are possible once in a given number of years, can be computed with analytical formulas in terms of the distribution parameters. On the example of the dual exponential law of yearly extrema of average wave heights, it is shown that, depending on the selection of the estimate of distribution parameters β and s, the values of the calculated wave heights can differ among themselves by up to 15%. The need for further study of the entire question is recognized. Figures 1, formulas 14, references 11: Russian 9, Western 2.

UDC 551.556.3

Interaction Between Wind Flow and Wind Power Plant

[Article by S. L. Zubkovskiy, V. M. Lyatkher, M. M. Fedorov and L. R. Tsvang, Atmospheric Physics Institute, USSR Academy of Sciences]

[Abstract] A wind power plant with a vertical axis was set up in 1987 in the Tsimlyansk observation area of the Atmospheric Physics Institute, an even area measuring 700 x 700 m surrounded by level cultivated fields. The rotor blades were fabricated from segments of helicopter blades. The middle of the blades (2.55 m long, 0.4 m wide) was situated 4.1 m above the ground surface. The frequency of rotor rotation was from 75 to 112 rpm. Prior to field tests the power plant was tested in a wind tunnel at the Central Aero-Hydrodynamic Institute. Simultaneous measurements were made of the instantaneous powers produced by the wind power plant and the characteristics of the wind speed field: mean wind speed, wind profile, dispersion and spectra of wind speed fluctuations in the oncoming flow and in the wake. It was found that the plant power output increases with an increase in flow turbulence level despite a constant mean wind speed. The wind speed field in the power plant wake almost completely recovers its properties at a distance of about seven power plant diameters. Figures 7; references 7: 4 Russian, 3 Western.

UDC 551.521.3

Spatial-Angular Selection of Laser Signals Reflected by Diffuse Screen Placed in Turbid Medium

[Article by A. G. Ushenko and M. A. Neduzhko, Chernovitse State University]

[Abstract] A method was developed for the spatial-angular discrimination of a laser signal reflected by a diffuse screen situated in a water medium. The method is based on a polarization "cutoff" of background noise created by scattering on optical path inhomogeneities. A diagram illustrates the apparatus used and the experimental scheme. An LGN-502 laser was used. A polarization filter consisting of a quarter-wave plate and polarizer formed different types of sounding beam polarization. The polarization structure of the field of scattered radiation was analyzed using a system consisting of a quarter-wave plate and a linear analyzer. The receiving system field of view angle was 30'. The diffuse screen used was a plane steel polished surface. The screen was immersed into water with suspended monodisperse 1-μm latex particles. The proposed model representations of spatial-angular selection of the information present in the laser radiation field adequately describe propagation processes in a turbid medium containing a diffuse reflecting screen. Regions of scattering space were discovered in which the effectiveness of discrimination of a laser signal against the background of noise generated by inhomogeneities on the optical path is substantially greater than in the incidence plane. Figures 4; references: 5 Russian.

UDC 551.576.2:551.465.63(261.1)

Correlation Between Cloud Cover and Water Surface Temperature Anomalies in North Atlantic Ocean

[Article by V. M. Mirvis, candidate of geographical sciences, and I. P. Guseva, Main Geophysical Observatory]

[Abstract] A study was made to determine the spatial-temporal localization of the strongest correlations between anomalies of the quantity of cloud cover and the thermal state of the ocean surface, to give a physical interpretation of these correlations and to clarify their consequences. The study was based on series (approximately 20 years) of mean monthly cloud cover and water surface temperature anomalies in grid units 5 degrees in latitude and 10 degrees in longitude computed on the basis of archival data. In the subtropical zone of the North Atlantic there are two types of synchronous correlation of anomalies of cloud cover quantity and thermal state of the ocean surface: summer (in the east), for which a decisive influence of cloud cover anomalies is characteristic, and winter (in the west) with a decisive influence of the thermal state of the ocean. Series of asynchronous correlations were discovered between cloud cover anomalies of the two defined types and preceding and subsequent anomalies of the thermal state of the ocean, an important factor in which is an accentuation of the subpolar hydrological front in November-December. The series of correlations confirm the probable initial development of processes in conformity to the scheme of interaction between the ocean and atmosphere proposed by V. G. Kort in OKEANOLOGIYA, Vol XVI, No 4, 1976, and indicate a possible succession of processes in the western and eastern parts of the North Atlantic subtropics. Figures 3; references 16: 15 Russian, 1 Western.

Synoptic Variability of Processes of Heat and Moisture Exchange Between Ocean and Atmosphere in Middle-Latitude Frontal Zones in Ocean

[Article by S. K. Gulev and A. V. Kolinko, candidates of physical and mathematical sciences, State Oceanographic Institute]

[Abstract] The processes of middle-latitude energy exchange between the ocean and the atmosphere in the range of synoptic scales are examined. The analysis is made using files of observations from the NEWFAEX-88 experiment, carried out in a region where the main feature of the hydrological structure is the subpolar hydrological front, characterized by sharp surface temperature gradients. Three structural zones were defined for analytical purposes: zones of warm and cold waters situated to the south and north of the hydrological front and a frontal zone where there are increased ocean surface temperature gradients. Local increases in heat flows from the ocean to the atmosphere in the frontal region of the Newfoundland Energy-Active Zone were discovered which are associated with the interaction between an essentially spatially inhomogeneous oceanic surface and highly nonstationary atmospheric synoptic processes. Computations of heat flows at the ocean-atmosphere interface are given for different structural zones in the ocean for different atmospheric situations. An approach based on a joint examination of the characteristics of an oceanic front (temperature gradients, front orientation) and atmospheric circulation is used in describing synoptic interaction processes in frontal zones. Simple relations are proposed for estimating the flow of heat and moisture in a frontal zone. The results of computations of heat flow fields in this region and estimates of the accuracy of the proposed parametrizations are given. Figures 3; references 13: 7 Russian, 6 Western.

Accumulation of Acoustic Noise Generated by Turbulent Shearing Stresses in Near-Surface Atmospheric Wave Guide

[Article by S. D. Danilov and M. A. Mironov, Atmospheric Physics Institute, USSR Academy of Sciences]

[Abstract] The spectral density of the mean square of acoustic pressure excited by turbulent fluctuations of shearing stresses on an underlying surface was computed. The capture of acoustic waves by a near-surface wind wave guide results in an accumulation of acoustic energy near the underlying surface and a corresponding increase in the spectral density of sound. This increase is dependent on frequency and therefore the near-surface wind wave guide acts on acoustic noise as a frequency filter. In addition, there is a spatial (along the wind) filtering of the acoustic noise accumulated in the wave guide. At not excessively low frequencies the shearing stresses are a stronger source of acoustic noise than the quadrupole sources associated with free isotropic turbulence. The absolute spectral density values, estimated from turbulent shearing stresses on a smooth surface, are thousandths of a Pa^2/Hz at frequencies near 1 Hz in the case of an adequately great (10^6 m) horizontal extent of the wave guide. The scattering of short-wave fluctuations of near-surface pressure results in an increase in shearing stresses in comparison with a smooth surface and therefore the absolute spectral density values may also be great in the case of not such a significant horizontal extent of the wave guide. The enhancement of noise due to sound capture by a near-surface wave guide is substantial only for a definite frequency range, dependent on the wave guide parameters. References 16: 10 Russian, 6 Western.

Satellites Study the World Ocean

[Article by Yu. I. Zaytsev, Space Research Institute, USSR Academy of Sciences]

[Text] It is difficult to overstate the significance of the World Ocean to life on Earth. It is playing an increasingly more active part in man's economic life, and the attention of scientists to it is becoming more persistent. Space methods of exploring the ocean offer great possibilities.

Widening the Range

The principal merit of oceanological satellite research is the possibility for obtaining information on a global scale. It provides an opportunity for studying large-scale phenomena in the ocean and atmosphere making up a complex, continually interacting system affecting formation of weather and climate on Earth, and for evaluating the overall state of the ocean's resources and its rather fragile ecosystem.

The main parameters that we measure are atmospheric temperature and humidity at various altitudes, the nature of cloud cover, ice cover, and the state of the sea and ocean surface. Moreover these parameters vary both in time and in space, and this is one of the typical features of satellite research.

When measurements are taken in the visible spectrum (at wavelengths of 0.4-0.7 μ), the largest amount of information is contained in the spectral composition of

the ascending light flow. From it, we can judge the biological productivity of the water, determine the boundaries of water masses, and detect eddies, zones of upwelling water and other dynamic formations. In coastal regions we can readily distinguish continental runoff, its distribution and its interaction with waters of the open sea by its color.

The requirements imposed on apparatus used in oceanological satellite research are somewhat different from those pertaining to similar research on land. The diversity of colors, shades and contrasts on land is incomparably wider than on the ocean surface, and natural formations possess rather abrupt and distinct boundaries. In ocean waters they are dozens of times less pronounced, and a more complicated procedure must be used to get a geographic fix on observation results. This is why the spatial resolution of the apparatus is not as important as its sensitivity, as its spectral resolution.

Clouds are an insurmountable obstacle to visible and infrared radiation. To compound the problem, a significant part of our planet's surface is constantly covered by them. Nor can apparatus operating in the visible range cannot be used to take measurements on the night side of Earth. Hence the desire to widen the range of wavelengths used for observation purposes, and to develop new methods of remote determination of the parameters of the atmosphere, the ocean and the continental surface.

Experiments were begun in this direction in the Soviet Union in 1967 with the satellite Kosmos-149 (the "Kosmic Arrow"). It was continued by Kosmos-243 (1968) and Kosmos-384 (1970) with apparatus taking measurements at 8 mm and 1.35, 3.4 and 8.5 cm wavelengths. Note that the USA conducted similar experiments 4 years later.

This selection of wavelengths imparted the greatest informativeness to the measurements. At the shortest of these wavelengths, a cloud-free atmosphere is transparent, while emissions from clouds are proportional to the quantity of water they contain. The 1.35 cm wavelength corresponds to the resonance line of water vapor, and atmospheric emissions at this wavelength are proportional to the concentration of water vapor in air. Waves in the centimeter range freely pass through clouds and precipitation, and they can be used to assess temperature and surface state. Simultaneous measurements of the Earth's thermal radiation have made clear interpretation of experimental results possible. Thus allweather study of the environment's properties has become a possibility.

Online determination of the global distribution of water vapor in the atmosphere independently of cloud cover is especially important to meteorology. Transport of water vapor from the oceans is what supplies the continents with moisture, you see, and the heat that is liberated when it undergoes condensation is one of the sources of energy feeding cyclones and other synoptic formations. Satellite measurements have made it possible to obtain information for the first time on the concentration of water droplets in clouds, and on their redistribution in the atmosphere. Zones of thick cloud cover and precipitation can be identified.

Using radio emissions in the centimeter range, we have begun accurately determining ocean surface temperature and monitoring the development and dissipation of storms independently of cloud cover. The following examples show how important data on the temperature of ocean waters are. Deviations from the norm in the distribution of warm and cold waters of the Atlantic Ocean observed in spring and summer 1972 influenced the movement of air masses with the consequence of evoking a severe drought in a number of regions of the central USSR. In February 1980 the ocean temperature within the zone of origin of the Gulf Stream was 1.5-2°C below the mean annual norm. A month and a half to two months later satellites noted this anomaly as far away as a point east of Newfoundland. Then this zone shifted toward the shores of Europe. As a result, European countries were broadsided by cold and rain.

In polar regions, remote sensing at centimeter wavelengths provides information on the boundaries of the distribution of sea ice, and on the cohesiveness and structure of ice fields. This is possible because the intensity of thermal radio emissions from water and ice differs, and the internal structure of ice determines certain peculiarities in the spectra. The value of such sensing in inaccessible regions independently of lighting conditions and cloud cover is difficult to overstate.

The First Specialized Satellite

In February 1979 the Soviet Union launched its first specialized oceanographic satellite, Kosmos-1076. The comprehensive information received from it about the World Ocean had the purpose of improving weather predictions and studying hydrophysical and biological fields. A year later the second satellite of the same type, Kosmos-1151, was launched.

The scientific gear of the satellites included:

- a 16-channel visible-range spectrometer to determine sea water characteristics from the spectrum of outgoing radiation, with a resolution of around 20 km;
- a 10-channel infrared radiometer to determine sea surface temperature and atmospheric parameters, with spatial resolution on the order of 25 km;
- a 4-channel microwave radiometer to determine sea surface temperature, sea disturbance intensity, wind force, the characteristics of ice cover, atmospheric humidity, the water content of clouds and their intensity; its spatial resolution was from 18 km at a wavelength of 0.8 cm to 85 km at 8.5 cm.

Joint processing of the results of measurements taken in different portions of the electromagnetic spectrum and comparison of the results of remote and contact measurements opened up broad prospects for collecting objective information on the state of the World Ocean

and the atmosphere on a global scale. It became possible to obtain a rather complete impression of the state of the ocean, and of the basic types of variability of its fields, which is the dominant element of ocean dynamics. In short, it became possible to form the first data bank containing information on the World Ocean acquired from space.

But it was too soon to say that a permanent oceanological research service had arisen in the USSR. Many unsolved problems still remained.

Creation of the Information Collection and Transmission System

As is true of the atmosphere, the ocean possesses its own "weather" on the backdrop of climatic variations. Determination and prediction of these variations required a significant increase in the volume of measurements of oceanological parameters. A widely branching network of meteorological and hydrometeorological stations was created to solve the similar problem in meteorology. Correspondingly, one of the main objectives in the development of oceanographic satellite systems was to develop, create and test out a dependable system for collecting and transmitting operational information (SSPI) from marine, ship and ground buoys to data processing centers.

The apparatus used to collect data from automatic buoy stations and scientific research vessels, and transmit them to receiving centers, was tested out for the first time with Kosmos-1076.

Field tests were conducted with the experimental SSPI by means of the satellite Interkosmos-20, launched in November 1979. This system worked on the basis of a demand principle. In this case accumulated information is transmitted from a buoy not continuously but only after certain signals are received from the satellite. When necessary, for example in adverse weather, a buoy may be switched to standby systems or its operating conditions may be changed by a command from the satellite. The energy consumption of such demand systems is low, which is especially important with platforms established in the open ocean.

The experimental space system began operating for the first time in February 1981 after the satellite Interkosmos-21 was launched. It consisted of two oceanographic satellites—Kosmos-1151 launched in 1980 and the international Interkosmos-21. On one hand the satellites were complementary in their instrumentation, while on the other hand they made it possible to observe the same areas from different altitudes at the intersections of their orbits and to compare the obtained data.

The launching of the satellite Kosmosl-1500 in October 1983 was an important step forward in the development of remote research on the World Ocean. It did not differ in its design from its predecessors; however, the tasks for which it was intended had a greater practical orientation. A spacecraft providing for transmission of information

on the ocean directly to its users, around the clock and in all weather, was created for the first time in our country. Organizations of the USSR Maritime Fleet were the users. Information on the ice situation in the eastern sector of the Arctic, obtained under the conditions of the polar night, when it was impossible to employ apparatus operating in the visible range, was used to pilot ships through these regions.

But one problem still remained unsolved. Hundreds of times more information was obtained during just the time of work of the first oceanographic satellite than over the long years of operation of all expeditionary seagoing vessels. Only high-power computers could handle such a flow of information. Moreover in order that they could process this information, an enormous quantity of the most diverse information had to be fed into them—on mean annual characteristics of different regions of the World Ocean, and on the influence of lighting conditions, wind and the state of the atmosphere on registration of ocean characteristics. In short, we needed to thoroughly analyze what it was specifically that the satellite instruments were recording.

It became obvious that control and calibration measurements had to be organized along satellite tracks. These measurements needed to be taken at sea, at different altitudes in the atmosphere, and from space. Comparison of spectral observations with the results of contact measurements of the characteristics of the water surface are what allowed us to create a "spectral image" or "spectral portrait" of the sea—the way it appears from different altitudes, including from space.

Such integrated research was begun in the mid-1980s. Besides Soviet scientists, specialists of many other countries took part in it. Special attention was devoted to the atmosphere. If color differences between land and water are visible through a turbid atmosphere, you see, many nuances of light that reveal the secrets of the "internal life" of the sea and the atmosphere could be masked or distorted in such a way that they would be interpreted incorrectly. Data obtained in the course of this research had great significance to space hydrophysics. They made it possible to significantly optimize the work of satellite systems for observing the ocean, and automate data processing.

New Possibilities

The next step in the development of satellite research on the World Ocean was the launching of a heavy oceanographic spacecraft of a new generation by the Soviet Union in July 1987—Kosmos-1870, outfitted with a radar set of special design which made it possible to obtain imagery of practically any land surface in all weather and at any time with a resolution of 10-30 m.

The first satellite radar systems provided an opportunity to distinguish surface details with dimensions of just 1-2 km from space orbit. This was of course fully sufficient for ice reconnaissance for example. However, these radar systems operated at shorter wavelengths (2-3 cm), at

which the influence of atmospheric interference is high. Equipping Kosmos-1870 with a radar system having an operating wavelength of 10 cm alleviated this problem.

In addition it became possible to use a special radiotechnical method, the synthetic aperture method (the aperture is a measure of resolution determined usually by antenna size). A satellite moving on a near-Earth orbit transmits a radio beam at some object on the planet's surface. The satellite manages to fly a certain distance while this object remains within the radar's field of view. At each point passed during this time on the trajectory, the satellite antenna can be interpreted as part of a giant antenna several kilometers in size. Of course in contrast to traditional radar methods, such a synthetic antenna operates not as a single whole but in parts: Its elements contribute to an observation successively as the satellite moves. In this case each element "sees" the terrestrial object from its own particular viewing angle. A special signal recording system and subsequent computer processing of the information make it possible to obtain a radar image of the Earth's surface in its most minute details, as if a radar system with an antenna measuring several kilometers were orbiting the Earth.

The fact that the wavelength of the Kosmos-1870 radar became commensurate with the length of sea waves made it possible to determine the intensity of ripples on the sea surface. This information may be used as a basis for assessing surface wind velocity, the value of which is necessary in turn to an assessment of energy exchange between the ocean and atmosphere. Moreover internal waves in the ocean, which are the result of interaction of currents with inhomogeneities on the ocean floor, also have an influence on ripple intensity. This is why banks, shallows and similar formations can be detected on the basis of the characteristics of surface manifestations of internal waves on radar imagery (slicks). They can also be used to detect changes in water density at depth, which depends chiefly on the temperature profile. Thus it was found to be possible to determine many parameters of fluctuations of the ocean's internal layers. The ocean surface serves in a sense as a large "screen" on which processes occurring within its depths are displayed.

Radar observations of the sea surface from aboard Kosmos-1870 made it possible to see the boundaries of currents and temperature boundaries, and to monitor their variability; they also made it possible to monitor formation of eddies in the ocean and development of the upwelling of abyssal waters.

Internal waves are also possible in the atmosphere, and they may be observed from ocean surface manifestations associated with variations they elicit in the velocity of surface winds. Consequently space radar sensing of the sea surface at high resolution makes it possible to study and monitor diverse processes and interactions in the ocean-atmosphere system.

Kosmos-1870 was outfitted with a magnetic information recording system. This allowed it to obtain "radio portraits" of any part of the planet, to store them in a "memory" and to transmit them as necessary to a ground station as the satellite flew over it. Herein lies the difference between the Soviet satellite and the American SEASAT (sea satellite) spacecraft launched earlier by the Americans, which could only transmit information directly to ground stations (one was located in the USA, and another in England). There could be no discussion of global observation in this case, of course, inasmuch as regions more than 1,000 km away from the ground stations were out of reach to researchers.

During the 2 years that the satellite Kosmos-1870 functioned, a large quantity of radar imagery of individual regions of the World Ocean and of various natural formations in the Soviet Union and in a number of foreign countries was obtained. The technical characteristics of the radar station and the high operating qualities of the satellite itself—a general-purpose space platform accommodating scientific apparatus weighing up to 3 tons which could be used to create spacecraft of various purposes—were fully confirmed.

We can hope that in the not-to-distant future, space methods of observation will help us piece together not only the surface but also the three-dimensional picture of phenomena occurring in the ocean. Thus development of an ocean new to mankind—the cosmic ocean—was also found to be useful to learning about an ocean that is closer and more commonplace, but far from fully studied and comprehended—the terrestrial ocean.

Photo Captions

Space photography was provided by associates of the USSR Hydrometeorological Center [photographs not reproduced].

[p 17] Radar image of the Ross Sea obtained by Kosmos-1500 on 22 July 1985, and the results of its processing in which spatial inhomogeneities were amplified. Owing to data obtained by the satellite on the ice situation (presence of fractures, cohesiveness of the ice, distribution of multiannual and year-old ice) and the recommendations developed on their basis, the icebreaker *Vladivostok* surmounted the mass of heavy ice relatively quickly and was able to lead the scientific expeditionary vessel *Mikhail Somov* out of its prison.

[p 19] Optical (left) and radar (right) images of tropical cyclone Diana by the shores of Florida, obtained by Kosmos-1500 on 11 September 1984. The "eye of the storm"—the center of reduced atmospheric pressure—observed in the clouds also made an "imprint" on the sea surface.

[p 20] Radar image of the ocean near the Japanese islands, obtained by Kosmos-1500 on 18 January 1985. Waves are weak on the land-encircled Sea of Japan (left), and they are more intensive on the Pacific shore (right).

Inhomogeneities in the sea wave field caused by inhomogeneities in the wind field, formation of which is influenced by the topography of the Japanese islands, are visible.

[p 21] The side-looking radar aboard Kosmos-1500 operating in the 3- centimeter waveband forms an image of a strip of the Earth's surface 460 km wide with a resolution of around 2 km. The photograph shown here (obtained 20 February 1986) was used in support of a KOMSOMOLSKAYA PRAVDA expedition under the leadership of D. Shparo traveling on skis across the Arctic Ocean in the darkness of the polar night to the station Severnyy Polyus-27.

[p 22] The island of Novaya Zemlya. The photograph was taken on 14 December 1988 by means of a miniature scanning device carried by the satellite Kosmos-1939, operating in the infrared range (10.3-11.8 μ). Clouds are visible to the left of the island over the Barents Sea, and the Kara Sea can be seen on the right, covered with ice. Unfrozen water by the shore has a lighter tone on the photograph. The bright branching lines on the ice-covered sea surface are water-filled fractures.

[p 23] Diagram showing the work of a synthetic aperture radar system. The radar transmits pulses obliquely toward Earth. They are partially reflected back to the satellite. The distance to the object within the radar's field of view is determined from the time it takes the pulses to travel this path. Equidistant objects are located on arcs of a circle with its center at a point located directly beneath the radar set. The frequency of signals from the equidistant objects is compared. Objects with the same Doppler frequency shift are located on branches of a hyperbola with its focus at a point located beneath the radar. Intersecting arcs are used to determine the object's coordinates. Each point within the radar's scanning strip is recorded several times over a small time interval. As a result the effective aperture of the radar system is much greater than the length of its microwave antenna.

Lidar Detection of Anomalous States of Mesospheric Sodium

[Article by V. M. Dubyagin and N. A. Shefer, Atmospheric Optics Institute, Siberian Department, USSR Academy of Sciences, Tomsk]

[Abstract] A regular Na layer with a maximal concentration is present at altitudes 88-95 km; a weaker, sporadic layer is present at 100-105 km. Optimal schemes were developed for the processing of lidar signals for the purpose of detecting anomalous states of this mesospheric Na. These schemes are technically simple and can be used with both existing resonance fluorescence lidars and with those still in development. These can supplement existing schemes for measuring Na concentrations. They are suited for three cases: for absence of a priori information on Na for different states of the mesosphere, when data are available on Na concentration profiles and when the Na profiles and concentrations are known. The efficiency of the detection schemes is highest when using a priori stipulated Na concentration profiles in normal and anomalous states. During the first stage, when such information is lacking, it is possible to use a scheme for detecting the sporadic layer. After accumulating statistical information on Na it will be possible to employ a more effective scheme for detecting anomalous concentrations in the regular layer. Figures 4; references 8: 5 Russian, 3 Western

Features of Temporal Structure of Radiation in Dense Scattering Media. Part II. Influence of Geometry Parameters in Experiment in Small-Angle Scattering Region

[Article by V. V. Vergun, Ye. V. Genin, G. P. Kokhanenko, V. A. Krutikov and D. S. Mezhevoy, Atmospheric Optics Institute, Siberian Department, USSR Academy of Sciences, Tomsk]

[Abstract] The first part of this research (OPTIKA ATMOSFERY, Vol 3, No 7, pp 691-697, 1990) dealt with a method for observing the temporal form of pulses propagating in a scattering medium. This second part gives the results of research on energy attenuation and the temporal structure of pulses, revealing that in the axial zone of the beam a joint role is played by singly and multiply scattered radiation. The research was done largely in the region of small-angle scattering (optical depth $\tau = 1$-20). A study was made of the broadening and exponential dropoff of the amplitude of pulses with depth for different observation angles. The influence of the angular aperture of the receiver on measurement of pulse duration and energy is evaluated. The results reveal a quite complex spatial-temporal structure of the scattered background in the mentioned range of optical depths. The relative contribution of singly and multiply scattered radiation is essentially dependent on the geometry parameters of the receiver. Figures 5; references: 6 Russian.

Algorithm for Optimal Processing of Nonmonochromatic Signal in Adaptive System for Autofocusing of Radiation

[Article by G. N. Dolya, I. V. Trushko and S. N. Shostko]

[Abstract] Adaptive systems based on wave front inversion are coming into increasing use in the processing of optical signals in order to compensate for the distorting effect of the atmosphere, but the algorithms proposed for use in such cases are based on the assumption of a monochromaticity of the used radiation, although such ideal signals are not actually observed. This article is devoted to a synthesis and analysis of an algorithm for the optimal processing of an optical signal of a non-monochromatic character in an adaptive system for the autofocusing of radiation in which allowance is made for the real width of the signal spectrum. Three possible variants of a solution are defined. In the selected variant it is necessary to introduce a new operation in the optimal processing algorithm for retrieving an undistorted image: inversion of the complex signal amplitude in time. References: 8 Russian.

Acoustic Method for Determining Laser Beam Structure Under Kinetic Air Cooling Conditions

[Article by Vl. V. Pokasov (deceased), V. V. Vorobyev, A. S. Gurvich, A. S. Dyakov and V. S. Pryanichnikov, Raduga Experimental Design Bureau, Moscow]

[Abstract] The possibility of retrieving the distribution of energy density in the cross section of a laser beam (with allowance for the gradual transfer of the absorbed energy of the radiation into heat and the kinetic cooling effect) is demonstrated on the basis of pressure measurements in a divergent acoustic wave generated by a laser pulse in the atmosphere. The results of experiments with radiation of a CO_2 laser in the real atmosphere reveal that measurements of acoustic pulses during the absorption of radiation at $10.6~\mu$ on an atmospheric path make it possible to obtain the energy distribution in such a laser beam if allowance is made for the kinetics of absorption of radiation within the framework of a simple model with one relaxation time. From such measurements it is also possible to evaluate the relaxation time for this model. In the future it may be possible to use laser beams with a known and stable cross-sectional energy distribution for more detailed investigations of the kinetics of absorption and the relative contribution

to the absorption coefficient from CO_2. Figures 4; references 10: 7 Russian, 3 Western.

Computation of Nonlinear Aberrations Accompanying Thermal Blooming of Wave Beams

[Article by A. P. Sukhorukov and E. N. Shumilov, Moscow State University]

[Abstract] Analyses of numerical solutions of the parabolic equation describing light propagation in nonlinear media indicate that in addition to nonaberrational distortions it is necessary to make allowance for nonlinear aberrational distortions of spatially restricted beams. In order to solve this problem, on the basis of the transfer equation for intensity and a parabolic equation for the wave eikonal a system of ordinary differential equations is derived for describing the stationary propagation of axisymmetric light beams in media with an arbitrary nonlinearity mechanism associated with aberrational distortions of any preset order. Using known recurrent relations between the coefficients of expansions into series of the principal elementary functions of infinite series, the derived system of equations is reduced to specific form for describing wave aberrations to the sixth order inclusive accompanying the propagation of Gaussian beams in media with cubic nonlinearity and during thermal blooming. An analysis of the integrals of motion of the system is given and the differential equations themselves are briefly analyzed. References: 8 Russian.

Influence of Spatial Inhomogeneity of Absorption Coefficient and Refractive Index of Medium on Curvature of Sounding Radiation Wave Front

[Article by I. P. Lukin, Atmospheric Optics Institute, Siberian Department, USSR Academy of Sciences, Tomsk]

[Abstract] A theoretical study was made of the characteristics of a narrow optical sounding beam propagating in a medium with slight saturation of resonance absorption. Using an aberration-free approximation an analytical solution is obtained for the second-order mutual coherence function for sounding radiation. The joint influence of spatial inhomogeneities of the absorption coefficient and refractive index of the medium on the characteristics of an optical sounding beam narrow in comparison with the transverse linear dimension of a beam of strong laser radiation is analyzed. Conditions

are found under which it is possible to measure the parameters of the absorbing medium from registry of image shift of the laser sounding beam behind the focusing lens. Formulas are derived which make it possible to determine the linear absorption coefficient and saturation intensity. References: 8 Russian

UDC 519.68:551.521.14

Retrieval of Vegetation Cover Parameters Using Spectral Brightness Coefficient

[Article by V. S. Antyufeyev and A. L. Marshak, Computer Center, Siberian Department, USSR Academy of Sciences, Novosibirsk; Astrophysics and Atmospheric Physics Institute, Estonian Academy of Sciences, Tartu]

[Abstract] An algorithm is proposed for retrieving the optical and geometrical parameters of the vegetation cover on the basis of data on the spectral brightness coefficients for reflected and transmitted scattered solar radiation. This is a development of earlier work by the authors along these lines (OPTIKA ATMOSFERY, No 11, pp 1206-1212, 1989). The algorithm is based on the Newton method. Formulas are derived for computing the derivatives of the spectral brightness coefficient with respect to the sought-for parameters of the medium using the Monte Carlo method and concise results of model computations for solution of the inverse problem are given. This problem is solved more easily with lesser values of the H index (leaf surface). For greater H values the proposed algorithm does not make it possible to retrieve the key parameters rapidly and with a high accuracy and therefore attempts are being made to devise a more effective modification of the described algorithm. References 12: 6 Russian, 6 Western.

UDC 528.77(202):65.011.56

Possibility of Using Synthesized Images in Automated Interpretation

[Article by S. V. Agapov, V. S. Biryukov, Yu. K. Orlov, V. V. Kiselev and V. A. Grashchenko]

[Abstract] An automated interpretation system is proposed for use with black-and-white zonal space photographs. Figure 1 is a block diagram of an automated working place for an interpreter (AWPI) based on use of a PS-4 synthesis instrument. Figure 2 is a block diagram of automatic matching of zonal images using a coordinate readout device. Figure 3 is a block diagram of automatic matching of zonal images using a coordinate readout device and a TV sensor. The functions of each of the modules of this system complex are briefly discussed.

The development of the AWPI based on use of the PS-4 instrument makes it possible to automate the interpretation process and ensures solution of the following problems: automatic allowance for geometrical distortions introduced by the optical system of the PS-4 instrument; automatic adjustment of illumination in each PS-4 optical channel for optimizing the colorimetric characteristics of the color-synthesized image; automatic rectification of images of fragments of near-vertical, oblique and panoramic photographs by an analytical method with their transfer from the PS-4 screen to a plotter or the screen of a color display; graphic and visual output of the interpretation results; measurement of the size of image elements; automated processing of the results of measurement of image elements; stereoscopic visual interpretation of a stereopair of photographs; measurement of the differences in absolute parallaxes in the stereoscopic interpretation of photographs. Figures 3; references: 3 Russian.

UDC 535.361.1

Features of the Temporal Structure of Radiation in Dense Scattering Media. Part III: The Use of Diffusion Approximations to Describe the Shapes of Pulses

[Article by V. V. Vergun, Ye. V. Genin, G. P. Kokhanenko, V. A. Krutikov, and D. S. Mezhevoy, Institute of Optics of the Atmosphere, Siberian Division of the USSR Academy of Sciences, Tomsk]

[Abstract] The results of diffusion approximations are compared with experimental results to determine whether it is possible to use diffusion methods to evaluate the extent and shape of pulses in dense ($\tau = 10$-70) layers of scattering medium. It was found that asymptotic solutions yielded an angular structure of radiation over time which did not match experimental results. A more realistic view is provided by a small angle diffusion approximation, however, the method also has some unsatisfactory features (it does not consider radiation scattered at large angles, which may form part of a signal). The experimental and theoretical dependences of pulse length on the optical depth of the layer are compared with estimates made using diffusion approximations. It is found that by modifying the small angle diffusion approximation one can describe the pulse polarization components. In the modification the effective diffusion coefficient increases as photon travelling time increases. Ranges in which asymptotic solutions are valid are evaluated. Figures 4; references 14: 11 Russian 3 Western

UDC 551.5.21

Color Temperature and Pseudoradiative Properties of a Rayleigh Atmosphere

[Article by V. P. Galileyskiy and A.M. Morozov, Institute of Optics of the Atmosphere, Siberian Division of the USSR Academy of Sciences, Tomsk]

[Abstract] Typically one characterizes the energy distribution of a radiation source using the temperature of the source and a spectral function which describes the radiative properties of the real object in relation to an absolute blackbody at the same temperature. In this article, the color temperature and a coefficient of pseudoblackness are defined for the case where the Earth's atmosphere, which is assumed to be a Rayleigh atmosphere, is illuminated by the sun, and the observer is on the Earth's surface. The color temperature is determined by comparing the ratio of spectral luminosities of the atmosphere and an absolute blackbody at two wavelengths ($\lambda = 0.42$ and 0.69 μm). The pseudoblackness parameter is calculated using formulas presented in the article. Calculations are done using a comuputer program in FORTRAN-77. Diagrams of the results are provided. It is found that when the zenith angle of the sun changes from 30-90 degrees, color temperature changes by a factor of 270. Pseudoblackness is inversely proportional to color temperature. This method can be used to monitor the optical condition of the atmosphere, solve problems in atmsopheric optics, and describe the character of the spectral distribution of luminosity in the visible. Figures 2; references 4.

UDC 528.8.044:502.58

Method for Satellite Measurement of Spectral Characteristics of Atmospheric Turbulence

[Article by I. N. Klepikov, Space Research Institute, USSR Academy of Sciences, Moscow]

[Abstract] The theoretical possibility and technical feasibility of a space Doppler radar operating in the 8-mm range for trajectory measurements of the spectral characteristics of signals reflected from atmospheric cloud formations are demonstrated. A block diagram of a proposed radar complex is presented, together with the recommended technical specifications. Computations were made of the principal characteristics of the radar outfit and system for the digital processing of signals. With a time of data accumulation of about 12 s the standard deviation of the evaluation of the width of the Doppler spectrum is about 5 cm/s for the characteristic
parameters of convective cloud cover. When planning and developing such a space radar success requires rigorous reciprocal matching of the characteristics of all components, including the orbital parameters and the system for orienting artificial earth satellites. Measurements and global monitoring of the vertical profile of the energy of atmospheric turbulence by means of a Doppler radar, in combination with traditional observation methods, will provide conditions for improving theoretical models of the atmosphere and the quality of prediction of the generation and development of typhoons. Figures 3; references 10: 7 Russian, 3 Western.

UDC 528.721.222

Use of Stereoautograph for Analytical Processing of Surface Photographs

[Article by Ye. I. Kalantarov, docent, candidate of technical sciences, V. I. Nefedov, docent, candidate of technical sciences, and S. S. Ogorodnikov, graduate student, Moscow Order of Lenin Institute of Geodetic, Aerial Mapping and Cartographic Engineers; I. I. Menukhov, candidate of technical sciences, Scientific Research and Planning-Design Institute for Block Assembly Construction, Tyumen]

[Abstract] Theoretical and practical problems related to the use of an ordinary analog universal steoreophotogrammetric instrument of the Carl Zeiss Jena stereoautograph type for the analytical processing of surface photographs on a computer are examined. Particular attention is given to a new method and theory of measurements of surface photographs on the stereoautograph with subsequent determination of instrument errors by an analytical method. The results of experimental work on the analytical processing of real surface photographs first measured on an ordinary Steko 1818 stereocomparator and then on a stereoautograph by the proposed method are presented. The experimental results are consistent with another, evidence of the correctness of the method and theory of measurements of surface photographs on a stereoautograph with their subsequent computer processing. Figure 1; references: 4 Russian.

UDC 528.721.21

Photogrammetric Processing of Photograph Stereopairs Obtained by Survey Cameras With Slotted Shutters

[Article by A. P. Mikhaylov, docent, candidate of technical sciences, Moscow Order of Lenin Institute of Geodetic, Aerial Mapping and Cartographic Engineers]

[Abstract] Mathematical models for obtaining images with survey cameras with slotted shutters and methods for their stereophotogrammetric processing are examined. The processing is very difficult because it is impossible to use the traditional algorithms developed for photographs obtained by central projection. Two different variants of such processing for stereopairs, whose applicability is governed by the possibilities for use of technical devices and methods for independent determination of the position and orientation of the survey camera at the time that the photographs are taken, are outlined. A variant which involves no technical devices for determining survey camera position and orientation is best used in processing space photographs because the trajectory and orientation of the survey camera carrier are most stable (it can be assumed that the angular elements of outer orientation at the time of photography are constant). In the case of aerial photographs there may be a need for a more complex model than that described in the article. Figures 2; references: 2 Russian.

UDC 528.7.629.78

Preliminary Results of Evaluation of Anthropogenic Pollution of Southeastern Part of Baltic Sea

[Article by S. V. Vakhnichenko, graduate student, Laboratory for Monitoring Environment and Climate, USSR State Committee for Hydrometeorology and Environmental Monitoring and USSR Academy of Sciences]

[Abstract] A study was made to determine the anthropogenic state of Klaypeda (Lithuania) and adjacent part of the Baltic Sea after processing of space information registered by the "Cosmos-1939" satellite on 30 June 1988. The surveyed area is shown (Fig. 1). A diagrammatic map (Fig. 2) was constructed showing the results of processing of space information for the southeastern Baltic and Klaypeda in the spectral range 0.8-0.9 μm. Another map (Fig. 3) shows results obtained by digital synthesization of three spectral ranges for the same area. The field of concentration of suspended matter in the waters of the southeastern Baltic was determined (Fig. 4). The results of processing of space information are confirmed by the vector field of current velocities in the southeastern part of the Baltic Sea (Fig. 5). The field of distribution of the fraction of phytoplankton in the total mass of suspended matter in the southeastern Baltic Sea (there is a significant decrease shoreward) was ascertained (Fig. 6). The most polluted area is Kurskiy Gulf which lies off Klaypeda. Figures 6; references: 2 Russian.

UDC 528.225...521.6

Observability of Initial Values of Elements of Keplerian Orbit When Using Collinearity Condition in Processing of Synchronous Photographs of Earth and Star Sky

[Article by T. K. Dedova, graduate student, Moscow Order of Lenin Institute of Geodetic, Aerial Mapping and Cartographic Engineers]

[Abstract] This study is a continuation of an earlier article by this author in the same journal (No 5, pp 82-90, 1989) entitled "Research on the Observability of the Initial Conditions for the Motion of Resources Satellites From the Directions of Satellite-Centered Vectors in an Inertial Coordinate System." An estimate is now made of the initial values of the elements of a Keplerian orbit using coordinates of points on the Earth's surface on topographic photographs oriented in inertial space in order to ascertain the observability of this system. The fundamental possibility of an unambiguous refinement of the initial values of all six elements of the Keplerian orbit is demonstrated under the condition that the values of the first approximation of the refined parameters are sufficiently close to their true values. It is shown that information on the position of points on the Earth's surface exerts no influence on conclusions concerning observability of the considered dynamic system. [By observability is meant the possibility of retrieval of the vector of state of some system on the basis of measurement data.] References: 5 Russian.

UDC 528.71

Determining Limiting Conditions of Aerial Survey for Detecting Landscape Elements With Known Dimensions and Reflectivities on Photographs

[Article by I. V. Almazov, docent, candidate of technical sciences, V. N. Ovechkin, candidate of technical sciences, A. F. Stetsenko, docent, candidate of technical sciences, V. I. Filippov, candidate of technical sciences, and R. I. Fimin, docent, candidate of technical sciences, Moscow Order of Lenin Institute of Geodetic, Aerial Mapping and Cartographic Engineers]

[Abstract] The limiting conditions for an aerial photographic survey and the limiting parameters of a photographic system, making it possible to obtain images with a stipulated contrast and resolution, are validated. The described method is based on use of transfer functions

for modulation of individual components of an aero-survey system. Formulas are derived, for example, which make it possible to determine the maximal altitude of photography from which features with given linear dimensions and brightness coefficients will show up on a film having a given resolution and contrast at a limiting spatial frequency if the photographs are taken with a survey camera with a stipulated angle and for a stipulated solar zenith distance. The role played by each of the pertinent factors and their interaction are examined. These formulas make it possible to compute the limiting survey conditions and the principal parameters of the survey camera and film. The photographs obtained with such optimized survey parameters are then more suitable for solving problems related to environmental protection, research on natural resources and compilation of cartographic products. Figure 1; references: 8 Russian.

UDC 525.7:528.8

Balloon Experiment for Measuring Atmospheric Radio Emission at Wavelength 5 mm

[Article by A. A. Vlasov, Ye. N. Kadygrov, A. S. Kosov, I. A. Strukov, A. V. Troitskiy, A. N. Shaposhnikov and V. M. Aniskovich, Space Research Institute, USSR Academy of Sciences, Moscow; Central Aerological Observatory, Dolgoprudnyy; Radio Physics Scientific Research Institute, Gorkiy]

[Abstract] During August-September 1989 a balloon experiment was carried out at Rylsk for measuring radio emission at a wavelength 5 mm using a 6-channel microwave radiometer with a response from 0.09 to 0.6 $K \times s^{-1/2}$ with sounding to an altitude 40 km. The principal technical specifications of this radiometer are given in a table. Three flights were made. During two flights soundings were made to the nadir and during the third sounding was upward at an angle 15 degrees to the zenith. The program for each flight included a 1 1/2-hour balloon ascent to 30-32 km, a half-hour drift at that altitude and capsule descent by parachute. Each balloon consisted of a chain of 90 tethered envelopes each 200 m in length. All six channels of the microwave radiometer operated normally under real conditions. In general, there was a satisfactory agreement between the measured and computed antenna temperatures. The possibility of determining stratosphere temperature on the basis of radio emission measurements at a wavelength 5 mm using a microwave radiometer was confirmed. Figures 3; references 21: 17 Russian, 4 Western.

Sensitivity of Remote Determination of Spectral Albedo of Sea to Variations in Atmospheric Parameters

[Article by S. Keevallik and A. Kheynlo, Astrophysics and Atmospheric Physics Institute, Estonian Academy of Sciences, Tallinn]

[Abstract] This article represents an expansion on earlier work by the authors (ADV. SPACE RES., Vol 7, No 2, pp 2(31)-2(35), 1987). The errors in determining ocean albedo which can be caused by an incorrect estimate of both the concentration of aerosol and the aerosol phase function are estimated. Numerical experiments were made at five wavelengths (443, 520, 550, 670 and 750 nm) for atmospheric models in which surface horizontal visibility was varied in the range from 5 to 23 km but the aerosol scattering phase function could have a form characteristic for continental haze or for marine aerosol. Computations were made for three specific models of the real atmosphere which depending on the optical thickness of the aerosol are called "turbid," "intermediate" and "pure." It is shown that although the absolute albedo value determined for one spectral channel is extremely sensitive to variations in atmospheric parameters the ratio of the signals in two spectral channels is only slightly dependent on these variations. Figure 1; references 14: 5 Russian, 9 Western.

Surface Cold Spots in Northern Part of Sea of Okhotsk Determined From Satellite Data

[Article by I. A. Zhabin, Yu. I. Zuyenko and G. I. Yurasov, Pacific Ocean Oceanological Institute, USSR Academy of Sciences, Vladivostok]

[Abstract] An analysis of satellite IR images obtained during the years 1980-1988 by NOAA satellites (40 cloud-free fragments were examined) and hydrological data were used in a study of the position of surface cold spots bounded by tidal fronts which separate vertically mixed and stratified waters in the northern part of the Sea of Okhotsk. (These special fronts, called tidal fronts, also are observable on the shelf of Northwestern Europe, in the Bering Sea, in Cook Strait and in the Gulf of Maine). The time of appearance and disappearance of these spots also was ascertained. The cold spots appear in late June-early July when formation of the summer thermocline begins. The blurring of thermal contrasts occurs in September-early October when stratification is

destroyed in the course of autumn-winter cooling. In these cold spots the waters are mixed from the surface to the bottom. During this season the waters are stably stratified (the heated surface water mass is separated from the underlying cold layer by the seasonal thermocline). Only tidal mixing can result in the formation of these cold spots which appear against a background of a heated surface layer. Figures 2; references: 6 Western.

UDC 551.46.0:629.78

Spectral-Angular Method for Retrieving Ocean Surface Temperature Using Two-Channel IR Measurements

[Article by A. M. Ignatov, Marine Hydrophysics Institute, Ukrainian Academy of Sciences, Sevastopol]

[Abstract] Model computations were made for comparing the effectiveness of single-channel and different two-channel (spectral, angular and spectral-angular) methods for determining ocean surface temperature from IR measurements in the wavelength range 10-13 μm. All pertinent factors were taken into account other than cloud cover and aerosol. Each of these variants are separately examined in detail. An evaluation is made of the role of the principal interfering factors: attenuation in the molecular atmosphere, reflections from the surface, errors in measuring IR radiation. The spectral and angular positions of the optimal channels of the remote sensor are evaluated. Although the analysis was made without allowance for the influence of aerosol, an angular measurement scheme takes aerosol interference into account better than a spectral scheme. Allowance for aerosol attenuation is essential in the problem of determining ocean surface temperature and this requires serious additional research. The proposed methods have both merits and shortcomings. Choice of a particular variant requires a thorough analysis of both physical factors and the technical specifications of the instrument used. Figures 2; references 9: 5 Russian, 4 Western.

UDC 528.9:629.78

Possibilities of Radar Indication of Hydrocarbon Migration Zones

[Article by A. S. Gavrilenko, A. P. Pichugin, N. Ye. Zhuravel and A. N. Vasilyev, Institute of Animal Evolutionary Morphology and Ecology imeni A. N. Severtsov, USSR Academy of Sciences, Moscow; Kharkov State University imeni A. M. Gorkiy]

[Abstract] Radar sounding at a wavelength 3 cm using a side-looking radar carried aboard an Il-18 or other suitable aircraft may be an effective method, in combination with field work, for discovery of petroleum and gas deposits. Processing of field work data revealed a high contrast of gas-bearing and nonproductive territories in the northeastern Dnepr-Donets basin on the basis of the content of active calcium and sodium ions and the granulometric composition of the upper part of the humus horizon in soils. Hydrocarbon deposits stand out against the background of a normal geochemical field as sources of local disturbances. A quantitative analysis of the results of such a radar survey made in the territory of the Shebalin gas condensate deposit and in the adjacent nonproductive Alekseyevskaya area revealed a considerable radar contrast. The intensity of the reflected signal within sectors in the productive area is greater than outside it by an average of 4 db. There is therefore a considerable contrast in the principal physicochemical parameters of soils in a zone of hydrocarbon migration in comparison with background sectors and a corresponding change in the specific effective scattering area in productive and nonproductive areas. This suggests the possibility of using radar in field work in exploration for petroleum and gas fields. Figures 2; references 4: 3 Russian, 1 Western.

UDC 551.510.53

Wave Guide Effects in Propagation of Planetary Waves in Middle Atmosphere

[Article by E. I. Ginzburg and B. Ye. Stepanov, Experimental Meteorology Institute]

[Abstract] The propagation of planetary waves in the middle atmosphere is examined within the framework of a quasigeostrophic model with proper introduction of the refraction index. The propagation of a geopotential disturbance in the equatorial region is screened by a refraction barrier. This barrier (which arises due to the Earth's curvature) and the near-polar region form a global wave guide for planetary waves. Definite structures of mean zonal currents can form different local wave guides for planetary waves considerably narrowing the latitudinal distributions of disturbances. Due to wave guide effects the wave phase gradient loses its dependence on the lower boundary conditions with altitude and is determined there only by dissipative processes. For this same reason the distribution of amplitude at these altitudes is slightly dependent on the lower boundary conditions. Changes in the phase relations at the lower boundary cause changes in the amplitude refraction coefficients, which may lead to a change in the amplitude of the penetrating wave by several

times. Sudden stratospheric warmings may be related to this effect. Figures 4; references 22: 4 Russian, 18 Western.

UDC 551.466.82

Influence of Ice Conditions on Field of Radiation Emitted by Water Surface

[Article by V. V. Kazaryan and V. P. Korovin, Leningrad State University]

[Abstract] The results of research on the degree of influence of ice formations at the sea surface on the spectral brightness of the field of radiation emitted by the sea surface in the optical range of the spectrum of electromagnetic oscillations are given. By using emission at 550 nm it is possible to obtain more reliable and detailed information on the forms and age characteristics of ice. A spectrophotometric method is described which makes it possible to clarify the factors exerting an influence on the spectral brightness of the ice cover. Due to the sharp differences in spectral brightness between the ice cover and the open water it is possible to ascertain ice continuity, form and age and the quantitative characteristics of ice cover emission. The intensity of ice cover spectral brightness is dependent on hydrophysical and hydrooptical characteristics. The influence of the atmosphere on spectral brightness is manifested in an increase in absolute brightness values with altitude, although it is not identical in the spectrum, being particularly conspicuous in the blue-green region. The maximal intensity of the field of outgoing radiation is at 550 nm where the contrast between ice with different forms and age parameters is most significant. The intensity of ice cover emission is greater than the intensity of open water emission by a factor of 2-3. Aerial spectrometric measurements under good atmospheric transparency conditions are possible from altitudes 300-500 m. With the instrument used the optimal survey altitude was 1-2 km. Figure 1; references 3: 2 Russian, 1 Western.

UDC 551.551.5

Research on Coherent Structure of Tropospheric Turbulent Currents

[Article by N. Z. Pinus, Central Aerological Observatory]

[Abstract] This article is a continuation of earlier work by the author (IZV. AN SSSR: FAO, Vol 24, No 1, pp 3-8, 1988; METEOROLOGIYA I GIDROLOGIYA, No 5, pp 19-24, 1989; No 11, pp 27-32, 1989) and is devoted to a further clarification of the azimuthal (at different angles to the direction of turbulent currents) and spatial correlation of w' and v' (vertical and horizontal pulsations) and a more detailed study of the coherent structure of turbulent currents in the middle and upper troposphere. The materials used were from three flight expeditions at different altitudes from 1.5 to 8 km during which the aircraft intersected 121 turbulent zones with an extent from 20-30 to 200 km. The evolution of the $Coh_{wv}(k)$ spectra in different azimuthal directions is examined and the numerical Coh_{wv} values are given for the most frequently encountered coherent structures with allowance for wind direction in turbulent zones. The distinguishing feature of turbulent currents with a shear is a high degree of coherence at wave numbers determining ordering in the current structure. The selective nature of the distribution of coherent structures in turbulent currents must be taken into account when examining processes in which turbulent exchange is of considerable importance. Figures 4; references: 9 Russian.

UDC 551.521.3

Spectral Influx of Short-Wave Radiation in Cloudless Atmosphere

[Article by I. N. Minin and I. M. Tarabukhina, Leningrad State University]

[Abstract] Approximate formulas are proposed for the spectral influx of solar radiation in a cloudless atmosphere. A standard model of the atmosphere is used in which a plane layer is illuminated by a beam of parallel solar rays. The significance of various parameters is evaluated. Expressions are derived for determining optical depth for true light absorption in the atmosphere on the basis of the measured radiation fluxes. The inverse problem is examined and special cases are considered. These formulas and their properties can serve as an analytical basis for parametrization of the influxes of solar radiation in the atmosphere; they are are applicable to supracloud regions of the atmospheres of Venus, Jupiter and Saturn, the Earth's cloudless atmosphere and the atmosphere of Mars in the absence of dust storms. References: 3 Russian.

Climatic Lidar Monitoring of the Stratospheric Aerosol Layer

[Article by V. M. Zakharov, doctor of physical and mathematical sciences, S. S. Khmelevtsov, candidate of physical and mathematical sciences, Yu. G. Kaufman, A. P. Chaykovskiy, and B. B. Chen, Scientific Production Association "Tayfun"]

[Abstract] Information is given on lidar stations operated by the State Committee of Hydrometeorology that conduct regular measurements of the stratospheric aerosol layer. Currently the Committee operates four such stations located in Camaguey (Cuba), Teploklyuchenka (Kirgiz SSR), Obninsk, and Minsk. The Maket-1 lidars, jointly developed by the Institute of Physics and the Belorussian Academy of Sciences, are the main instruments used throughout the network, mostly at wavelength 0.53 µm. The composition and structure of the stratospheric aerosol databank in the Institute of Experimental Meteorology and the world-wide stations from which it receives lidar measurement data are described. It is concluded that the organization of lidar stations in the polar zone of the Northern Hemisphere, in the equatorial zone, and in the Southern Hemisphere (particularly in regions with frequent volcanic eruptions) must be further developed. Instrument calibration must be standardized throughout the world network. Figures 3; table 1 (worldwide stations); references 6: 5 Russian, 1 Western.

Modelling the Effect of Atmospheric Nuclear Explosions on the Content of Ozone in the Stratosphere

[Article by A. Izrael, V. N. Petrov, and D. A. Severov, USSR State Committee on Hydrometeorology, Institute of Applied Geophysics]

[Abstract] The effects of megaton-class nuclear bursts in the atmosphere on short-period local changes in the natural concentration of ozone, taking into account ozone formation in the atmosphere in the presence of the UV and gamma radiation from the nuclear fire ball, photochemical reactions in the burst cloud, and diffusion expansion of the burst cloud during its ascent and after its stabilization, are examined. Among the specific topics investigated are the significance of the additional ozone formation in the overall ozone balance, the change in ozone concentration in the ascending nuclear burst cloud, the effect on the ozone content $(H + OH)$ formed as the result of the dissociation of atmospheric water in the presence of the nuclear radiation from the fire ball, and the effect of temperature change in the stratosphere caused by dust injection. The magnitude of change in the ozone content in the stratosphere of the Northern Hemisphere is estimated following the injection of nitric acids and dust from a series of nuclear bursts, taking into account the heating of the stratosphere caused by dust from the bursts and natural self- purification of the atmosphere. The thrust of this paper is to access the environmental consequences of nuclear war. Calculations are based on the assumption that 10,000-Mt nuclear charges will be used in a nuclear war. The findings of Soviet researchers with regard to these questions are compared with US reports. Figures 4: references 17: 6 Russian, 11 Western.

UDC [551.510.41:551.510.532:551.588.7].001.57(100)

Anthropogenic Influence on Photochemistry and Gas Composition of Stratosphere

917N0015A Moscow METEOROLOGIYA I GIDROLOGIYA in Russian No 9, Sep 90 (manuscript received 8 Dec 89) pp 14-19

[Article by I. L. Karol, professor, and A. A. Kiselev, candidate of physical and mathematical sciences, Main Geophysical Observatory]

[Abstract] A one-dimensional, nonstationary radiative-photochemical model was used in estimating the gas composition and thermal regime in the atmospheric layer 0-50 m under conditions of increased concentrations of methane, nitrogen and chlorine compounds. The results of model research on the evolution of photochemical components of atmospheric cycles of a number of the main radiationally active gases in the global atmosphere with extrapolation of modern trends in the increase in anthropogenic discharge of a number of trace gases into the atmosphere for 50 years in advance under a number of different scenarios reveal that substantial qualitative and quantitative changes will occur. Whereas the composition of the photochemical source of ozone will not change appreciably, in the photochemical ozone sink in the upper and middle stratosphere there will be a substantial increase in the contribution of the chlorine group with a decrease in the contribution of the Chapman cycle by a factor of almost 10. Beyond a certain point the rate of decrease in ozone content will increase nonlinearly and the chlorine group will begin to play the main role in the photochemical ozone sink. However, the reaction between methane and atomic chlorine may prove to be a significant neutralizer and considerably reduce the intensity of ozone loss with an increased discharge of methane into the atmosphere. The decrease in ozone in the stratosphere will be accompanied by its cooling. The anticipated increase in tropospheric ozone content, for the most part with an increase in the entry of nitrogen oxides, will almost completely offset the decrease in stratospheric ozone so that the total ozone content, within model accuracy, will change little with different scenarios of increase in anthropogenic effluent. The quantitative estimates cited in the study are not prognostic because they are based only on the anticipated evolution of atmospheric photochemical processes and do not take into account other factors responsible for formation of the field of concentrations of trace gases in the atmosphere, especially their transport by atmospheric movements. Figures 3; references 7: 2 Russian, 5 Western.

UDC 528.7;550.837.82

Use of Parameters of Spectral Reflectivity Characteristic Curves for Natural Features in Thematic Processing of Remote Sounding Data

917N0033F Moscow IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: GEODEZIYA I AEROFOTOSYEMKA in Russian No 3, May-Jun 90 (manuscript received 20 Feb 90) pp 122-125

[Article by I. G. Zhurkin, professor, doctor of technical sciences, and V. A. Yanzhinov, graduate student, Moscow Order of Lenin Institute of Geodetic, Aerial Mapping and Cartographic Engineers]

[Abstract] Some aspects of use of spectral reflectivity characteristics (SRC) of natural features in the mathematical processing of images of the Earth's surface are examined. The most informative spectral characteristics are the spectral brightnesses and spectral brightness coefficients (SBC). This study is centered on a model of formation of the SBC of a natural feature (such as vegetation) which is based on three key vectors; a—characterizing the state of a feature as a function of such parameters as soil moisture content, salinity and type, projective cover of vegetation, phenophase, weed contamination, b—characterizing the survey conditions as a function of season, solar altitude, state and form of cloud cover, atmospheric transparency and azimuthal angles of sensor and S—characterizing the shape of the SBC. It is shown that by determining the degree of correlation between S, a and b it is possible to ascertain what components of state of the natural feature and survey conditions exert the greatest influence on the shape of the SBC and to select the most suitable form of the pertinent functional dependence. By knowing the specific form of the functional dependence for each component of the S vector, on the basis of change in the a and b vectors it is possible to predict the change in the shape of the SBC, which makes it possible to solve the inverse problem. In solving the inverse problem it is necessary to select those components of the S vector which correlate most closely with the components of the a vector when the b vector is fixed. This approach affords a possibility for automating thematic processing procedures. By knowing the limits of change of the components of the a and b vectors it is possible, from the variability of the SBC, to determine in advance the most informative spectral channels of the apparatus and the optimal time for carrying out surveys. References: 5 Russian.

State-of-the-Art of Waste Disposal in Geological Formations

[Article by L. A. Anisimov, Saratov State University]

[Abstract] Current practice in the disposal of radioactive, toxic and other dangerous wastes, with particular reference to U.S. experience, is surveyed with respect to geological, technological, economic, and ecological considerations. Subsurface repositories, which, in addition to their use as waste disposal sites, may also be utilized for the storage of oil and gas, fresh water, heat, and compressed air, are now considered natural resources whose correct utilization can yield economic gain. The classification of liquid wastes, proposed by P. P. Kostin and M. K. Pimenov in 1969, is still considered the most successful. With regard to toxicity, three types of waste are identified: type A - highly toxic wastes whose concentration in solution exceeds 10^{10} MPC; type B - average toxicity whose concentration exceeds 10^5-10^{10} MPC; and type C, 10^2-10^5 MPC. Depending on decay period, storage times range from 10 to over 1,000 years. Geotechnology offers four methods of liquid waste disposal: 1) in the upper hydrogeological zone; 2) artificial chambers in impenetrable formations; 3) artificial zones with improved filtration properties in slightly permeable formations; and 4) in high-capacity permeable repositories. A table lists the various repositories, natural rock formations, artificial environments. The Volgograd, Astrakhan, and Kalmytskaya areas are said to have the requisite geological formations for disposal and storage. A systematic approach is proposed for the development of a strategy and tactics of disposal in which the wastes would be run-off volume would be reduced, the volume of waste reduced, injection pumping systems calculated, etc. Considerable ecological damage was caused by injection pumping in the oil regions of Tatariya, Bashkiriya, and Kuybyshev, however. Measures are recommended to improve the reliability of waste disposal throughout the various processing stages. References 16: 8 Russian, 8 Western.

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